

# EPSON

SCARA ROBOT

*G3 series*

MANIPULATOR MANUAL

Rev.1

EM08ZR1795F

MANIPULATOR MANUAL      G3 series    Rev.1

SCARA ROBOT

# *G3 series Manipulator Manual*

Rev.1

## FOREWORD

Thank you for purchasing our robot products.

This manual contains the information necessary for the correct use of the manipulator.

Please carefully read this manual and other related manuals before installing the robot system.

Keep this manual handy for easy access at all times.

## WARRANTY

The Manipulator and its optional parts are shipped to our customers only after being subjected to the strictest quality controls, tests, and inspections to certify its compliance with our high performance standards.

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please ask your Regional Sales Office for warranty period information.)

However, customers will be charged for repairs in the following cases (even if they occur during the warranty period):

1. Damage or malfunction caused by improper use which is not described in the manual, or careless use.
2. Malfunctions caused by customers' unauthorized disassembly.
3. Damage due to improper adjustments or unauthorized repair attempts.
4. Damage caused by natural disasters such as earthquake, flood, etc.

Warnings, Cautions, Usage:

1. If the Manipulator or associated equipment is used outside of the usage conditions and product specifications described in the manuals, this warranty is void.
2. If you do not follow the WARNINGS and CAUTIONS in this manual, we cannot be responsible for any malfunction or accident, even if the result is injury or death.
3. We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.

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## NOTICE

No part of this manual may be copied or reproduced without authorization.

The contents of this manual are subject to change without notice.

Please notify us if you should find any errors in this manual or if you have any comments regarding its contents.

## INQUIRIES

Contact the following service center for robot repairs, inspections or adjustments.

If service center information is not indicated below, please contact the supplier office for your region.

Please prepare the following items before you contact us.

- Your controller model and its serial number
- Your manipulator model and its serial number
- Software and its version in your robot system
- A description of the problem

## SERVICE CENTER

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## MANUFACTURER & SUPPLIER

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## Before Reading This Manual

This section describes what you should know before reading this manual.

## Structure of Control System

The G3 series Manipulators can be used with the following combinations of Controllers and software.

The operating methods and descriptions are different depending on which software you are using. The following icons are put beside appropriate text as necessary. Use the descriptions that pertain to the software you are using.

Controller : RC180

Software : EPSON RC+ 5.0 Ver. 5.3 or greater

For details on commands, refer to User's Guide or "On-line help".

## Turning ON/OFF Controller

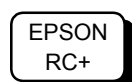
When you see the instruction "Turn ON/OFF the Controller" in this manual, be sure to turn ON/OFF all the hardware components. For the Controller composition, refer to the table above.

## Shape of Motors

The shape of the motors used for the Manipulator that you are using may be different from the shape of the motors described in this manual because of the specifications.

## Setting by Using Software

This manual contains setting procedures by using software. They are marked with the following icon.



## Figures in this Manual

The figures of manipulators indicated in this manual are basically Standard-model Manipulator. Unless special instruction is provided, the specifications of Standard-model and Cleanroom-model are the same.





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# Setup & Operation

This volume contains information for setup and operation of the G3 series Manipulators.

Please read this volume thoroughly before setting up and operating the Manipulators.






# 1. Safety

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes. Please read this manual and other related manuals before installing the robot system or before connecting cables.

Keep this manual handy for easy access at all times.

## 1.1 Conventions

Important safety considerations are indicated throughout the manual by the following symbols. Be sure to read the descriptions shown with each symbol.


 WARNING	This symbol indicates that a danger of possible serious injury or death exists if the associated instructions are not followed properly.
 WARNING	This symbol indicates that a danger of possible serious injury or death caused by electric shock exists if the associated instructions are not followed properly.
 CAUTION	This symbol indicates that a danger of possible harm to people or physical damage to equipment and facilities exists if the associated instructions are not followed properly.

## 1.2 Design and Installation Safety

Only trained personnel should design and install the robot system. Trained personnel are defined as those who have taken robot system training and maintenance training classes held by the manufacturer, dealer, or local representative company, or those who understand the manuals thoroughly and have the same knowledge and skill level as those who have completed the training courses.

To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the *EPSON RC+ User's Guide*.




The following items are safety precautions for design personnel:

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ Personnel who design and/or construct the robot system with this product must read the <i>Safety</i> chapter in the <i>EPSON RC+ User's Guide</i> to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems.</li> <li>■ The Manipulator and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems.</li> <li>■ The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems.</li> </ul>
---	---

Further precautions for installation are mentioned in the chapter *Setup & Operation: 3. Environments and Installation*. Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

## 1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ Please carefully read the <i>Safety-related Requirements</i> in the <i>Safety</i> chapter of the <i>EPSON RC+ User's Guide</i> before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.</li> <li>■ Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped.</li> <li>■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speeds and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly.</li> <li>■ Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated.</li> </ul>
 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.</li> <li>■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.</li> <li>■ Do not insert or pull out the motor connectors while the power to the robot system is turned ON. Inserting or pulling out the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system.</li> </ul>
 <b>CAUTION</b>	<ul style="list-style-type: none"> <li>■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions.</li> </ul>

## 1.4 Emergency Stop

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. Stops the power supply to the motor, and the arm stops in the shortest distance with the dynamic brake and mechanical brake.

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Otherwise, the Manipulator may hit the peripheral equipment since the operating trajectory while the robot system stops is different from that in normal operation.

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.

Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

### Free running distance in emergency

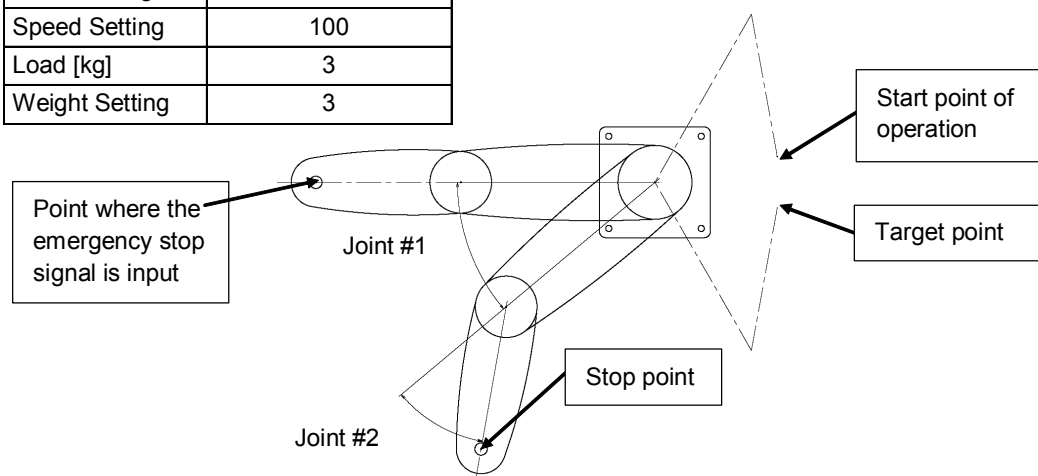
The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed.

The free running time/angle/distance of the Manipulator are shown below. However, remember that the values vary depending on following conditions.

Weight of the end effector    Weight of work piece    Operating pose  
Weight    Speed    Accel    etc.

#### Conditions for Measurement

Accel Setting	100
Speed Setting	100
Load [kg]	3
Weight Setting	3



Controller		RC180		
Manipulator		G3-25***	G3-30***	G3-35***
Free running time	Joint #1 + Joint #2 [sec.]	0.8	1.2	0.6
	Joint #3 [sec.]	0.6	0.6	0.6
Free running angle	Joint #1 [deg.]	41	53	57
	Joint #2 [deg.]	13	20	20
	Joint #1 + Joint #2 [deg.]	54	73	77
Free running distance	Joint #3 G3-***1** [mm]	95	95	95



## 1.5 Emergency Movement Without Drive Power

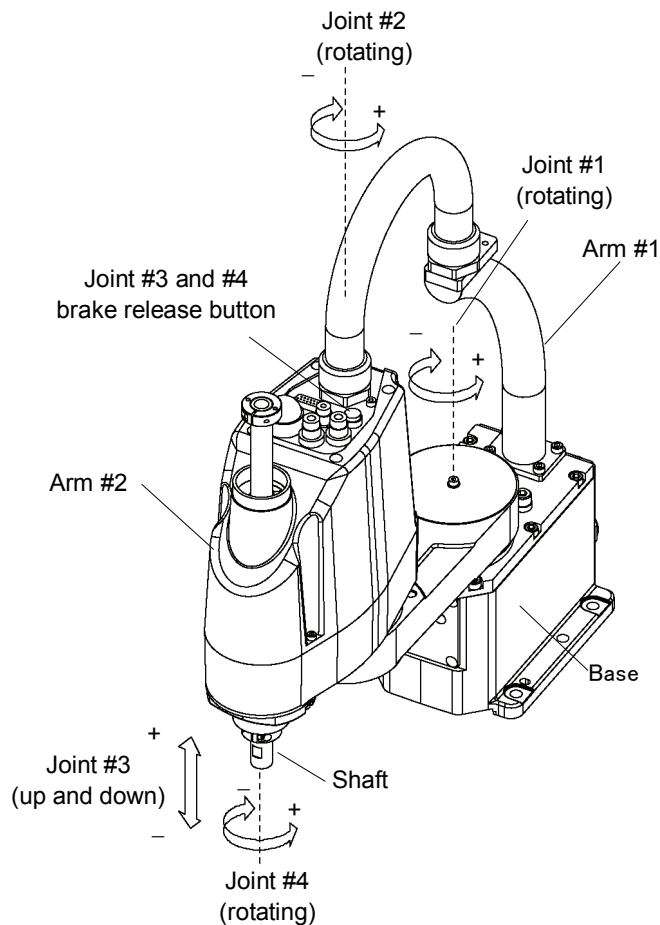
When the system is placed in emergency mode, push the arm or joint of the Manipulator by hand as shown below:

Arm #1 ..... Push the arm by hand.

Arm #2 ..... Push the arm by hand.

Joint #3 ..... The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release button switch.

Joint #4 ..... Rotate the shaft by hand.



### NOTE



The brake release button affects only Joint #3. When the brake release button is pressed in emergency mode, the brake for Joint #3 is released simultaneously.

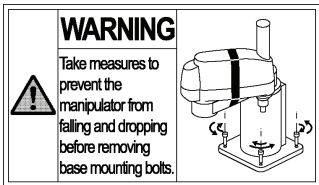
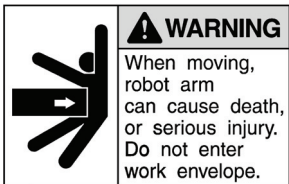



Be careful of the shaft while the brake release button is pressed because the shaft may be lowered by the weight of an end effector.

## 1.6 Manipulator Labels

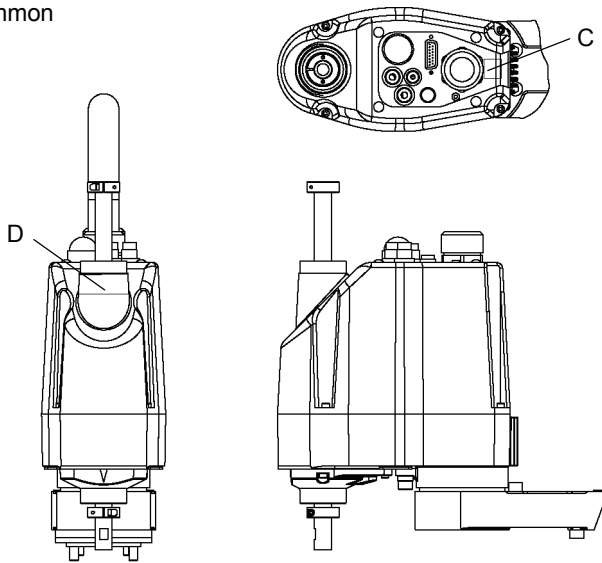
The following labels are attached near the locations of the Manipulator where specific dangers exist.

Be sure to comply with descriptions and warnings on the labels to operate and maintain the Manipulator safely.

Do not tear, damage, or remove the labels. Use meticulous care when handling those parts or units to which the following labels are attached as well as the nearby areas:

	Labels	NOTE
A		Before loosening the base mounting screws, hold the arm and secure it tightly with a band to prevent hands or fingers from being caught in the Manipulator.
B		
C		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.
D		You can catch your hand or fingers between the shaft and cover when bringing your hand close to moving parts.
E		HOT Be careful not to burn yourself.

Common



Multiple Mounting

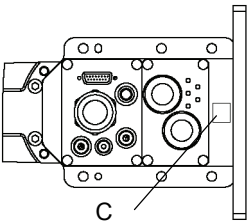
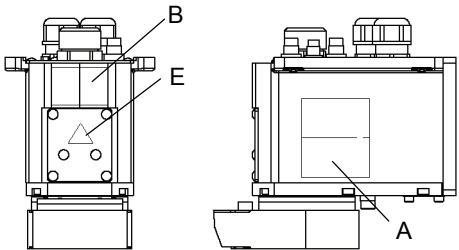
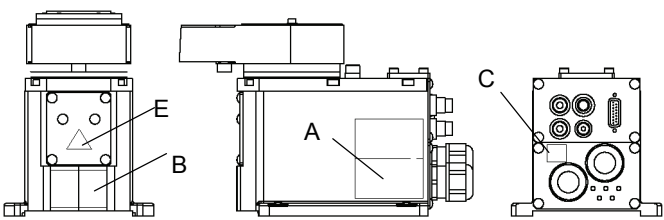


Table Top Mounting



NOTE     Manipulators with bellows do not have label D.  
☞     Because they have no risk of catching your hand or fingers.

## 2. Specifications

### 2.1 Features of G3 series Manipulators

The G3 series Manipulators are high-performance manipulators pursuing high speed, high accuracy, space saving, and high cost-performance.

The features of the G3 series Manipulators are as follows:

#### Space productivity

Top level of cycle time and positioning accuracy

#### *Minimized body*

10 % downsize of overall height in the rank

#### *Extended motion range*

The same size of motion range compared with the other brands' one up robots

#### *Extended range in Z direction*

Obtain the stroke under the body

#### Succeeded E2C series advantages

#### *Compatibility with the E2 series Manipulators*

The installation procedure and mounting dimensions of end effector for the G3 series are compatible with those for E2 series

\* Secure the compatible mounting position with optional parts

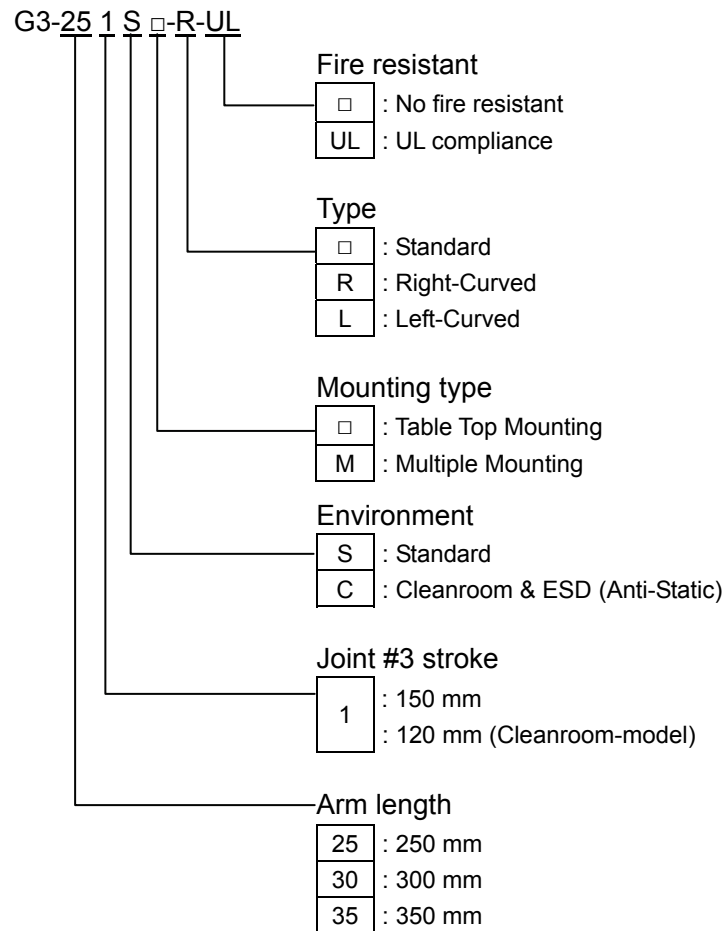
#### *Improved productivity*

Increase in number of user wires and pneumatic tubes

Enhanced speed of Joint #1, 2, 3, and 4

Improved cycle time

## 2.2 Model Number and Model Differences



### Environment

#### *Cleanroom-model*

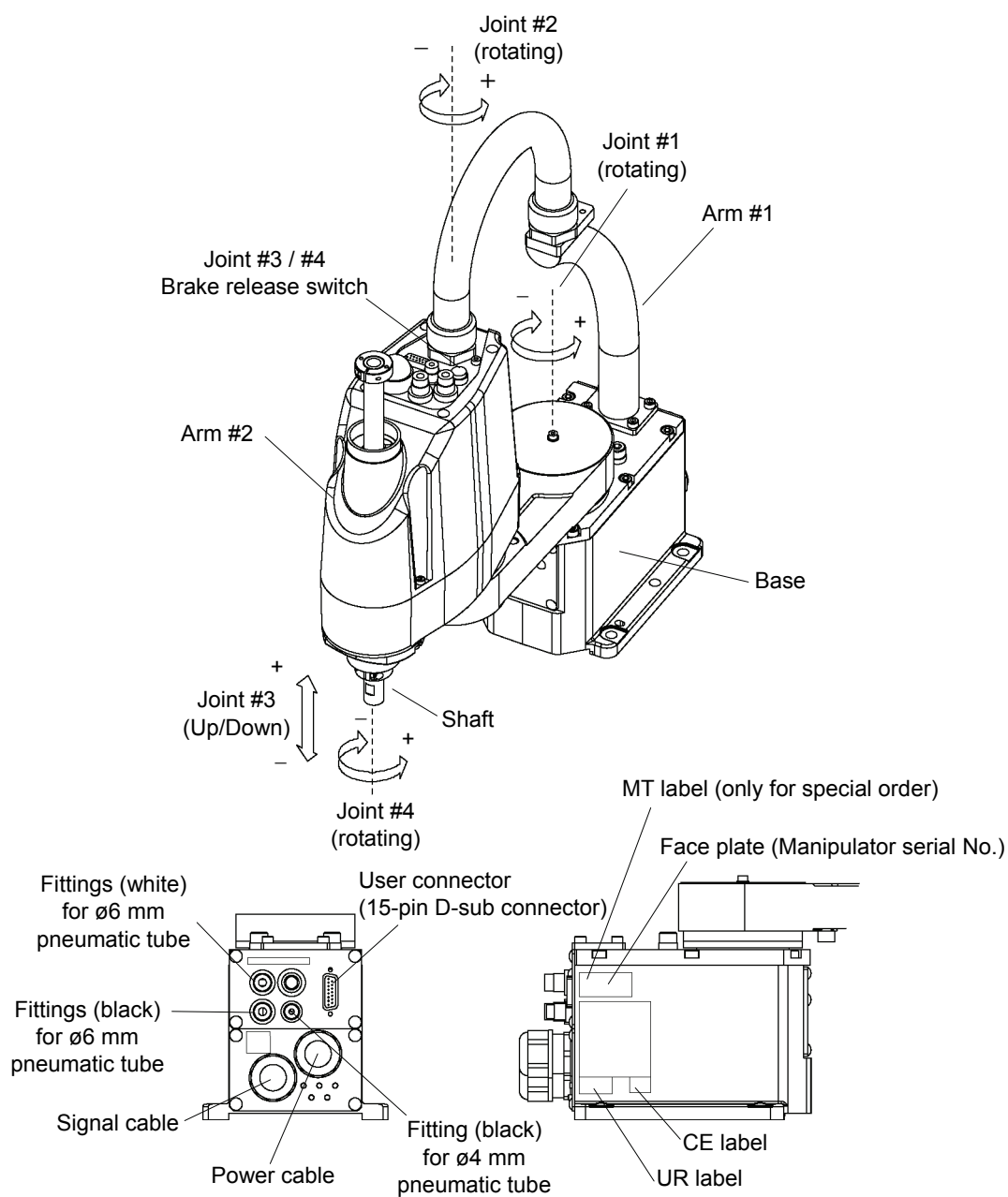
This model has additional features that reduce dust emitted by the Manipulator to enable use in clean room environments.

For details on the specifications, refer to *Setup & Operation: 2.4 Specifications*.

## 2.3 Part Names and Outer Dimensions

### 2.3.1 Table Top Mounting

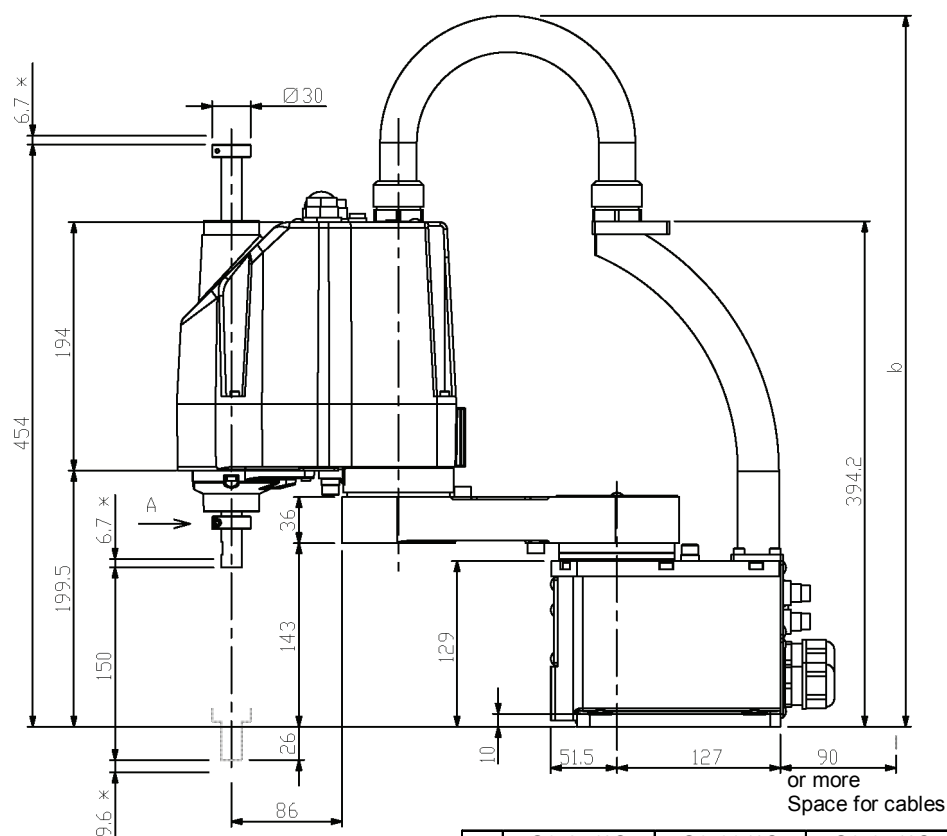
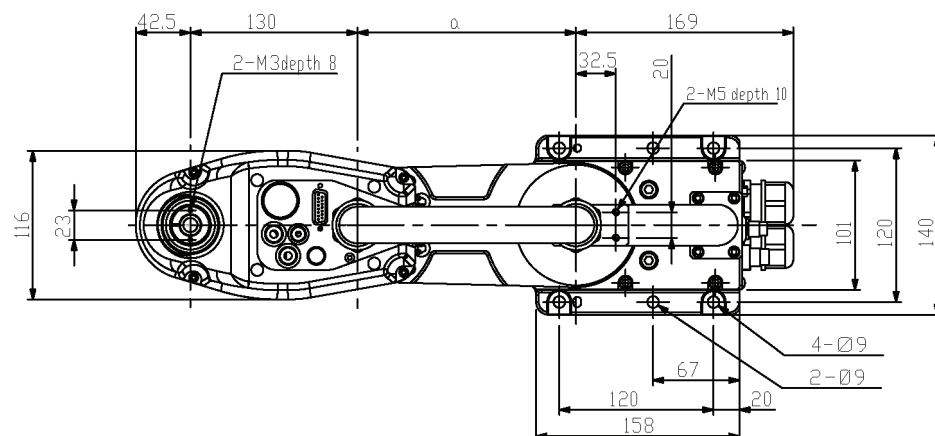
Standard-model G3-\*\*\*S



**NOTE**

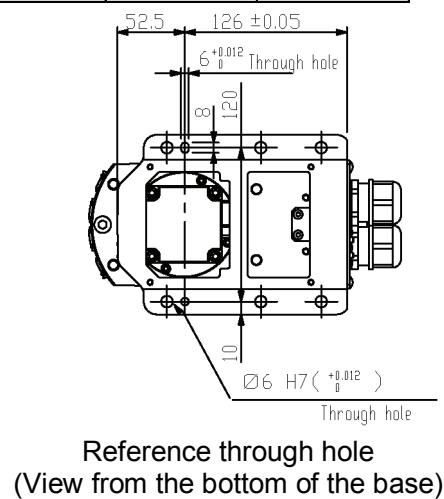
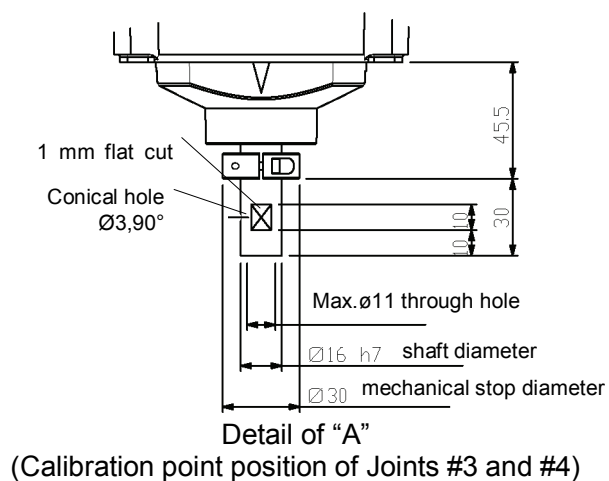


The brake release button affects only Joint #3. When the brake release button is pressed in emergency mode, the brake for Joint #3 is released simultaneously.



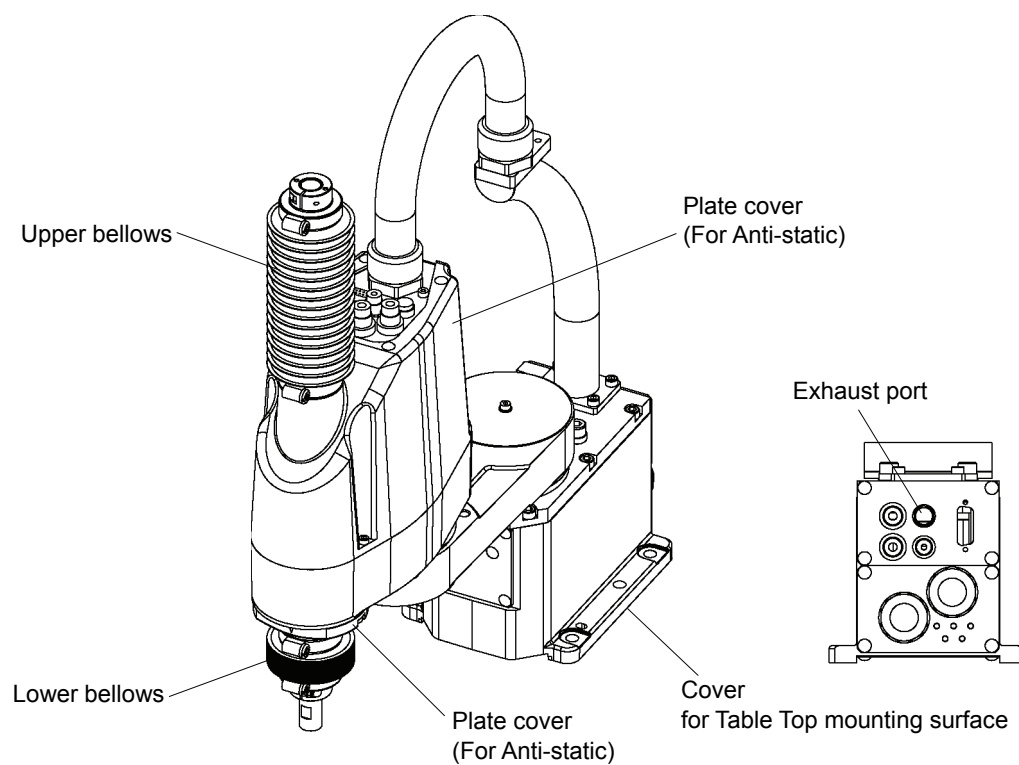
(\*) indicates the stroke margin by mechanical stop.

	G3-251*S	G3-301*S	G3-351*S
a	120	170	220
b	Max.545	Max.575	Max.595

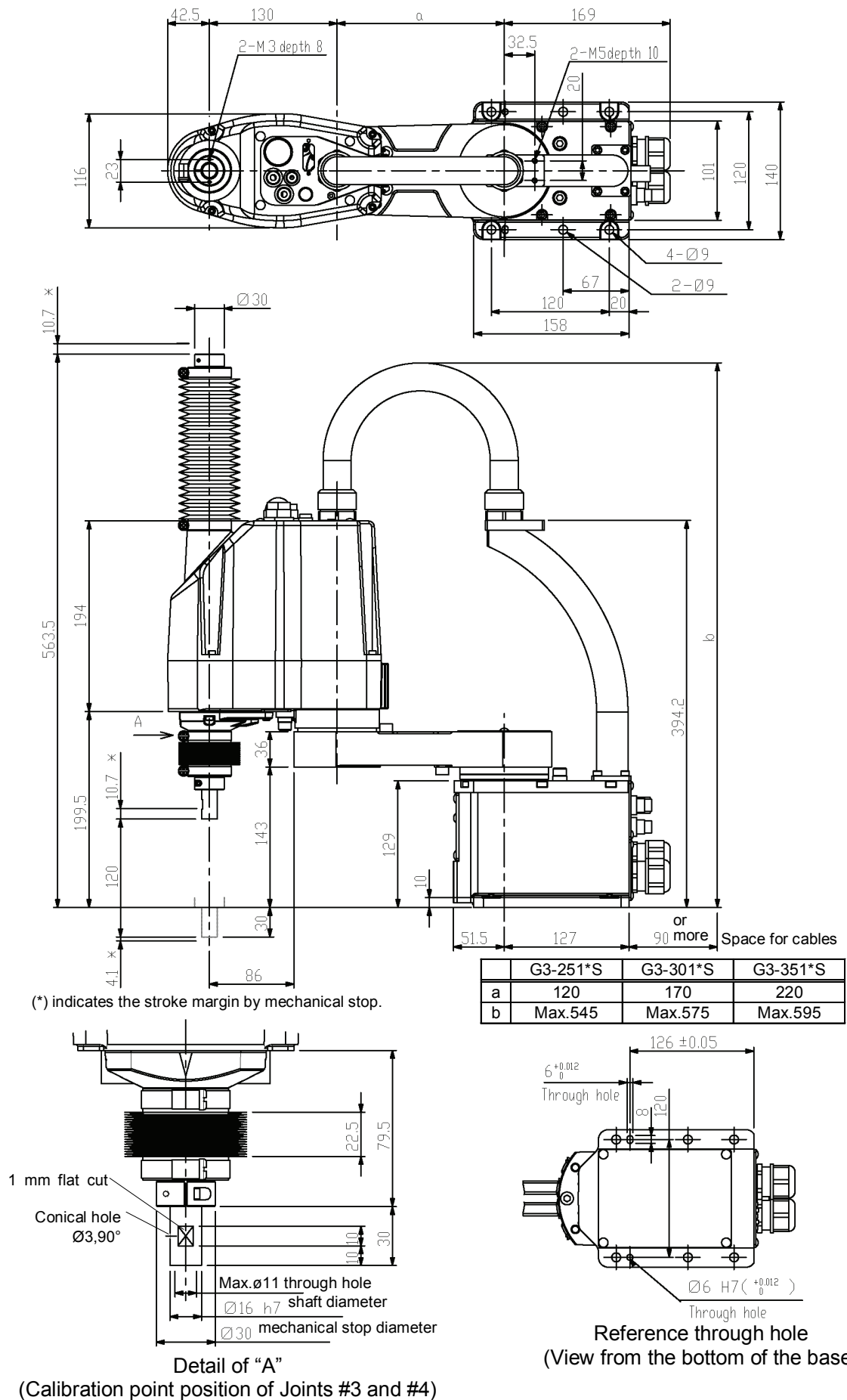


Cleanroom-model: G3-\*\*\*C

The following figures show the additional parts and specifications for Cleanroom-model (Table Top mounting) when compared with the Standard-model in appearance.

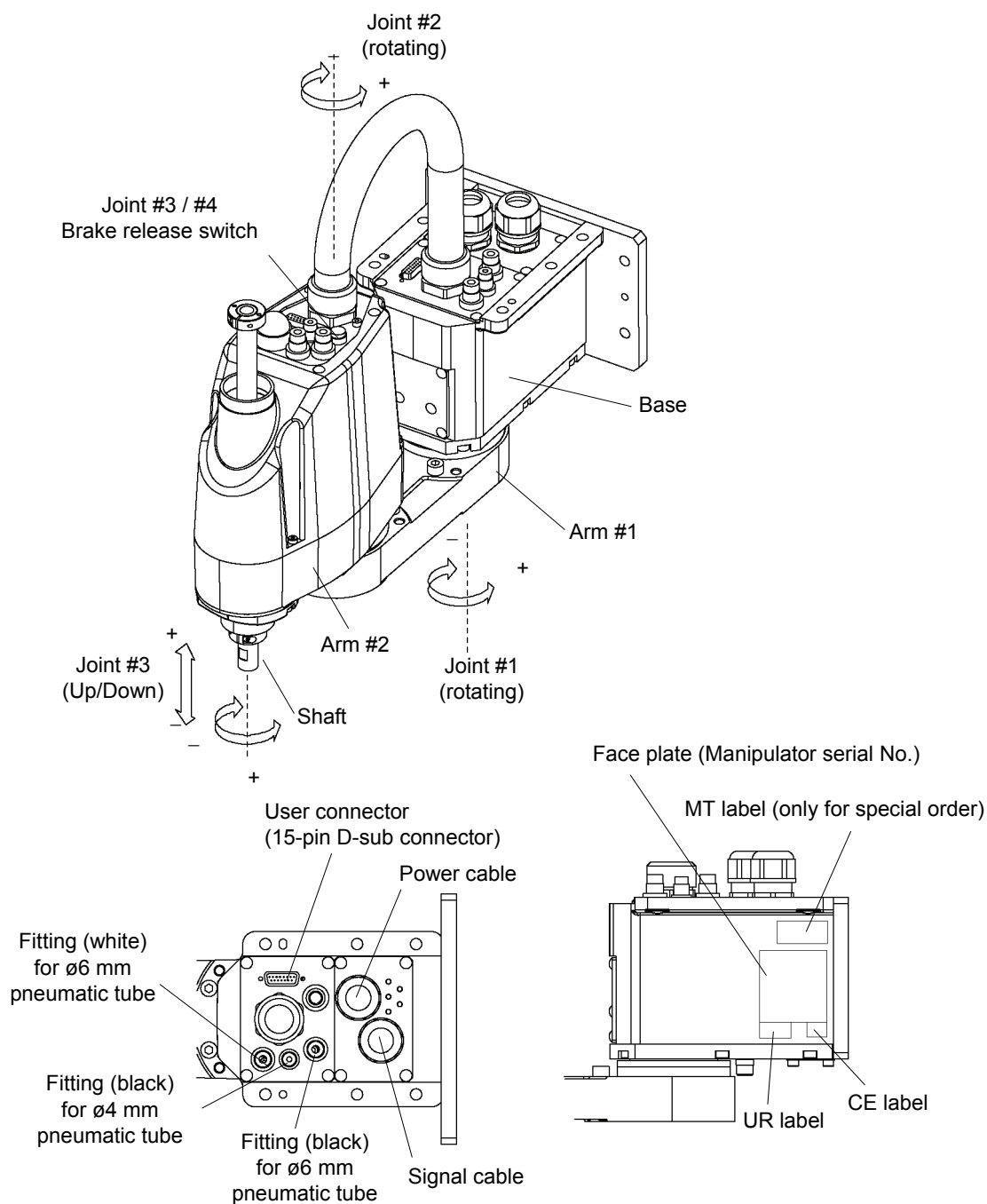






### 2.3.2 Multiple Mounting

Standard-model: G3-\*\*\*1SM

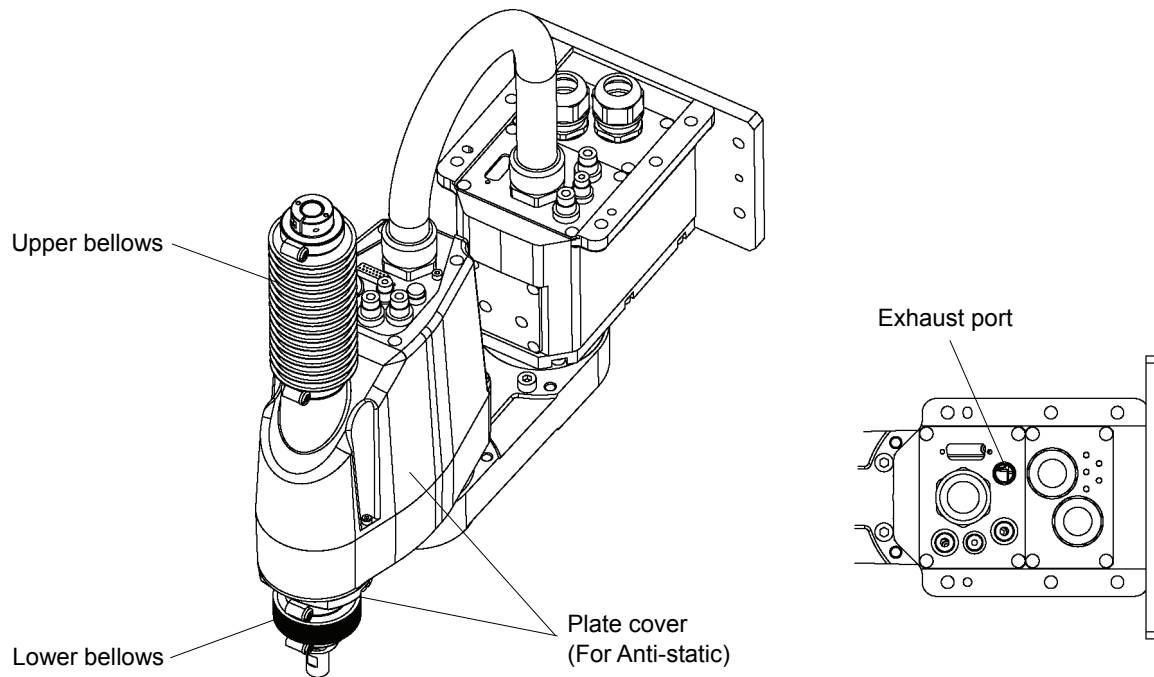


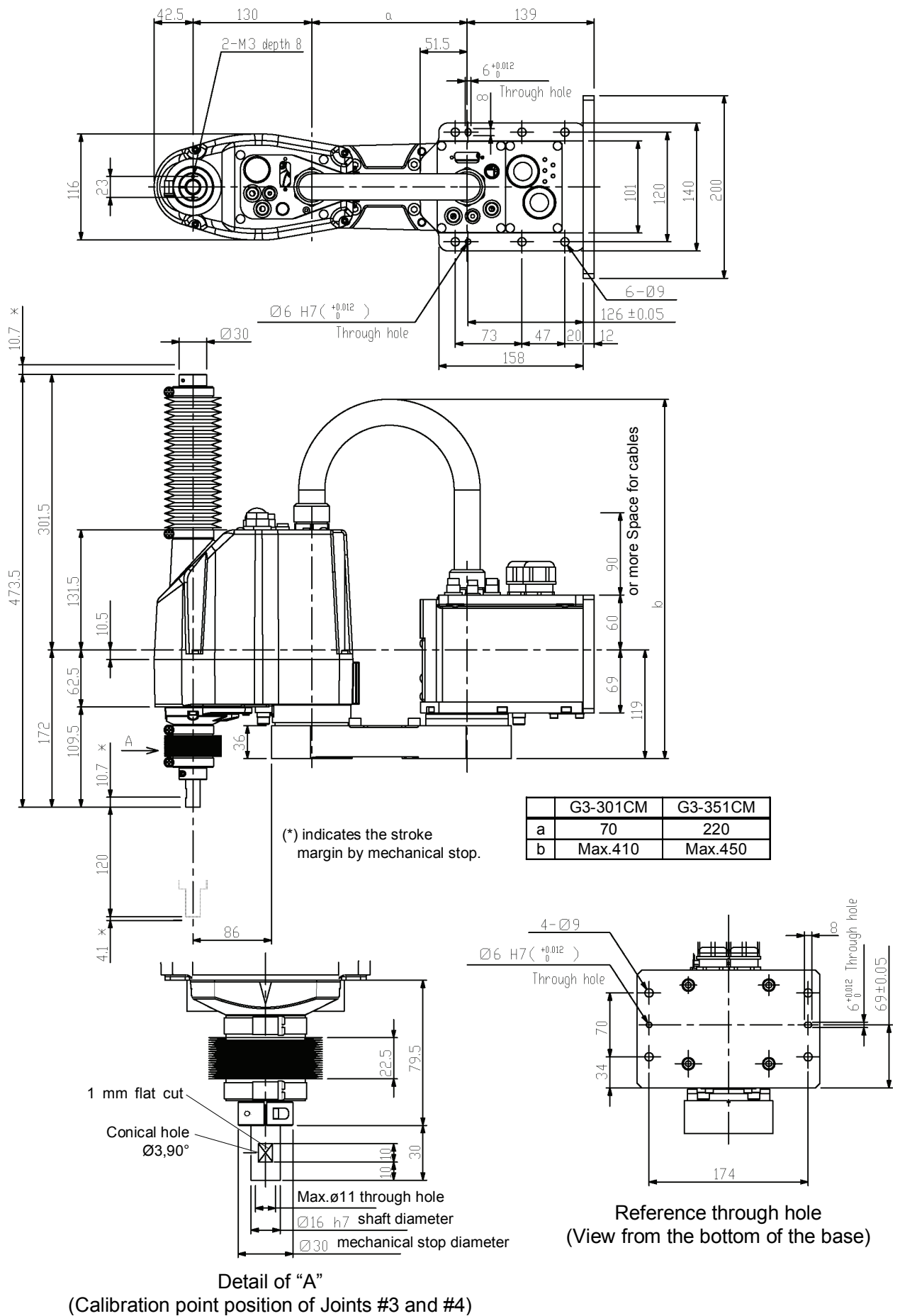
The brake release button affects only Joints #3. When the brake release button is pressed in emergency mode, the brake for Joint #3 is released simultaneously.



Cleanroom-model: G3-\*\*\*1CM

The following figures show the additional parts and specifications for Cleanroom-model (Multiple Mounting) when compared with the Standard-model in appearance.





## 2.4 Specifications

Item				G3 series Manipulator			
Arm length		Arm #1, #2		250 mm	300 mm	350 mm	
		Arm #1		120 mm	170 mm	220 mm	
		Arm #2		130 mm	130 mm	130 mm	
Max. operating speed *1		Joints #1, #2		3550 mm/s	3950 mm/s	4350 mm/s	
		Joint #3		1100 mm/s			
		Joint #4		3000 deg/s			
Repeatability		Joints #1, #2		± 0.008 mm	± 0.01 mm	± 0.01 mm	
		Joint #3		± 0.001 mm			
		Joint #4		± 0.005 deg			
Payload (Load)		Rated		1 kg			
		Max.		3 kg			
Joint #4 allowable moment of inertia *2		Rated		0.005 kg·m <sup>2</sup>			
		Max.		0.05 kg·m <sup>2</sup>			
Max. motion range	Straight	Joint #1		± 140			
		Joint #2		± 141	± 142		
	Curved	Joint #1	Right hand	-	- 115 to 150	- 105 to 160	
			Left hand	-	- 150 to 115	- 160 to 105	
		Joint #2	Right hand	-	- 135 to 150	- 120 to 165	
			Left hand	-	- 150 to 135	- 165 to 120	
	Common	Joint #3		150			
		Joint #4		± 360			
Max. pulse range	Straight	Joint #1		- 9786710 to 51729750			
		Joint #2		± 20534614	± 20680249		
	Curved	Joint #1	Right hand	-	- 5825423 to 55924054	- 3495254 to 58254223	
			Left hand	-	- 13981014 to 47768463	- 16311183 to 45438294	
		Joint #2	Right hand	-	- 19660800 to 21845334	- 17476267 to 24029867	
			Left hand	-	- 21845334 to 19660800	- 24029867 to 17476267	
	Common	Joint #3		-13653338 to 0			
		Joint #4		± 23907534			
Resolution		Joints #1		0.00000377134 deg/pulse			
		Joint #2		0.00000686645 deg/pulse			
		Joint #3		0.00001098632 mm/pulse			
		Joint #4		0.0001560107deg/pulse			
Hand		Shaft diameter		ø 16 mm			
		Through hole		ø 11mm			
Mounting hole				120 × 120 mm (4-M8)			
Weight (cables not included)				14 kg : 31 lb.			
Driving method		All joints		AC servo motor			
Motor energy consumption		Joint #1		200 W			
		Joint #2		150 W			
		Joint #3		150 W			
		Joint #4		150 W			
Option	Installation method			-	Multiple Mounting		
	Installation environment			Cleanroom *3 & ESD			
Joint #3 down force				150 N			
Installed wire for customer use				15 (15 pin: D-sub) 15 cores			
Installed pneumatic tube for customer use				2 pneumatic tubes (ø6 mm) : 0.59 Mpa (6 kgf/cm <sup>2</sup> : 86 psi)			
				1 pneumatic tubes (ø4 mm) : 0.59 Mpa (6 kgf/cm <sup>2</sup> : 86 psi)			

Item		G3 series Manipulator
Environmental requirements	Ambient Temperature	5 to 40°C (with minimum temperature variation)
	Ambient relative humidity	10 to 80% (no condensation)
Noise level *4		$L_{Aeq} = 70$ dB (A)
Applicable Controller		RC180
Assignable Value ( ) Default values	SPEED	1 to (5) to 100
	ACCEL *5	1 to (10) to 120
	SPEEDS	1 to (50) to 2000
	ACCELS	1 to (200) to 25000
	FINE	0 to (10000) to 65000
	WEIGHT	0,130 to (1,130) 3,130
MTBF		3 years
Safety standard		ANSI/RIA R15.06 compliant CE compliant

\*1: In the case of PTP command.

Maximum operating speed for CP command is 2000 mm/s on horizontal plane.

\*2: In the case where the center of gravity is at the center of Joint #4.

If the center of gravity is not at the center of Joint #4, set the parameter using Inertia command.

\*3: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior together.

A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Do not remove the maintenance cover on the front of the base.

Seal the exhaust port and the exhaust tube with vinyl tape so that the joint is airtight.

If the exhaust flow is not sufficient, dust particle emission may exceed the specified maximum level.

Cleanliness level : Class ISO 3 (ISO14644-1)

In previous criteria; Clean Class: 10 or its equivalent

Amount of Dust (0.1  $\mu$ m diameter or larger) in 28317 cm<sup>3</sup> (1cft)  
sample-air around the center of the motion range: 10 particles or less.

Exhaust System : Exhaust port diameter : Inner diameter:  $\phi$ 12 mm / Outer diameter:  $\phi$ 16 mm

Exhaust tube : Polyurethane tube

Outer diameter:  $\phi$ 12 mm (Inner diameter:  $\phi$ 8 mm) or

Inner diameter  $\phi$ 16mm or larger

Recommended exhaust flow rate : approx. 1000 cm<sup>3</sup>/s (Normal)

\*4: Conditions of Manipulator during measurement as follows:

Operating conditions : Under rated load, 4-joints simultaneous motion, maximum speed, maximum acceleration, and duty 50%.

Measurement point : In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

\*5: In general use, Accel setting 100 is the optimum setting that maintains the balance of acceleration and vibration when positioning.

However, you may require an operation with high acceleration to shorten the cycle time by decreasing the vibration at positioning. In this case, set Accel to larger than 100.

If you specify a larger Accel value, the frequency of the overload error and over heat may rise during continuous operation. The use of large Accel setting is recommended only for necessary motions.

## 2.5 How to Set the Model

The Manipulator model for your system has been set before shipment from the factory. It is normally not required to change the model when you receive your system.



CAUTION

- When you need to change the setting of the Manipulator model, be sure to set the Manipulator model properly. Improper setting of the Manipulator model may result in abnormal or no operation of the Manipulator and/or cause safety problems.

### NOTE



If an MT label is attached to the rear of a Manipulator, the Manipulator has custom specifications. The custom specifications may require a different configuration procedure; check the custom specifications number described on the MT label and contact us when necessary.

The Manipulator model can be set from software.

Refer to the chapter *Robot Configuration* in the *EPSON RC+ User's Guide*.



## 3. Environments and Installation

### 3.1 Environmental Conditions

A suitable environment is necessary for the robot system to function properly and safely. Be sure to install the robot system in an environment that meets the following conditions:

Item	Conditions
Ambient temperature *	5 to 40°C (with minimum temperature variation)
Ambient relative humidity	10 to 80% (no condensation)
First transient burst noise	2 kV or less
Electrostatic noise	6 kV or less
Environment	<ul style="list-style-type: none"> <li>· Install indoors.</li> <li>· Keep away from direct sunlight.</li> <li>· Keep away from dust, oily smoke, salinity, metal powder or other contaminants.</li> <li>· Keep away from flammable or corrosive solvents and gases.</li> <li>· Keep away from water.</li> <li>· Keep away from shocks or vibrations.</li> <li>· Keep away from sources of electric noise.</li> </ul>

**NOTE**



Manipulators are not suitable for operation in harsh environments such as painting areas, etc. When using Manipulators in inadequate environments that do not meet the above conditions, please contact us.

\* The ambient temperature conditions are for the Manipulators only. For the Controller the Manipulators are connected to, refer to the Controller manual.

#### Special Environmental Conditions

The surface of the Manipulator has general oil resistance. However, if your requirements specify that the Manipulator must withstand certain kinds of oil, please consult your distributor.

Rapid change in temperature and humidity can cause condensation inside the Manipulator.

If your requirements specify that the Manipulator handles food, please consult your distributor to check whether the Manipulator gives damage to the food or not.

The Manipulator cannot be used in corrosive environments where acid or alkaline is used. In a salty environment where the rust is likely to gather, the Manipulator is susceptible to rust.



**WARNING**

- Use an earth leakage breaker on the AC power cable of the Controller to avoid the electric shock and circuit breakdown caused by an unexpected water leak. Prepare the earth leakage brake that pertains the controller you are using. For details, refer to the controller manual.

## 3.2 Base Table

A base table for anchoring the Manipulator is not supplied. Please make or obtain the base table for your Manipulator. The shape and size of the base table differs depending on the use of the robot system. For your reference, we list some Manipulator table requirements here.

The torque and reaction force produced by the movement of the Manipulator are as follows:

Max. Reaction torque on the horizontal plate : 500 Nm

Max. Horizontal reaction force : 2500 N

Max. Vertical reaction force : 1500 N

The threaded holes required for mounting the Manipulator base are M8. Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9. For dimensions, refer to *Setup & Operation: 3.3 Mounting Dimensions*.

The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25  $\mu$ m or less.

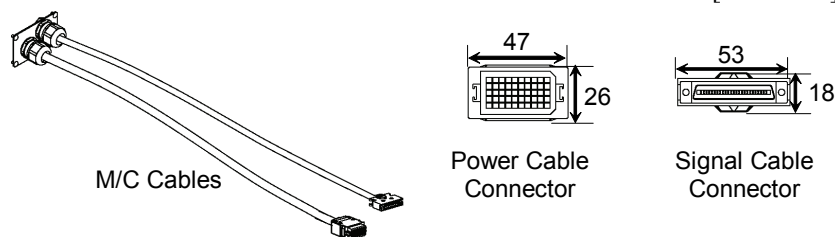
The table must be secured on the floor or wall to prevent it from moving.

The Manipulator must be installed horizontally.

When using a leveler to adjust the height of the base table, use a screw with M16 diameter or more.

If you are passing cables through the holes on the base table, see the figures below.

[unit : mm]



Do not remove the M/C cables from the Manipulator.



For environmental conditions regarding space when placing the Controller on the base table, refer to the *Controller manual*.



**WARNING**

- To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *EPSON RC+ User's Guide*.

### 3.3 Mounting Dimensions

The maximum space described in figures shows that the radius of the end effector is 60 mm or less. If the radius of the end effector exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.

If a camera or electromagnetic valve extends outside of the arm, set the maximum range including the space that they may reach.

Be sure to allow for the following extra spaces in addition to the space required for mounting the Manipulator, Controller, and peripheral equipment.

space for teaching

space for maintenance and inspection

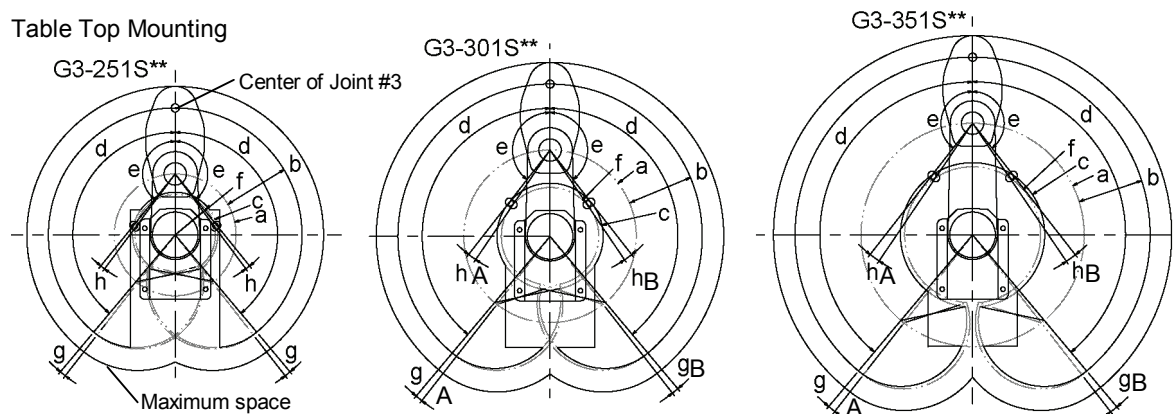
(Ensure a space to open the rear side cover and the maintenance cover for maintenance.)

space for cables

The minimum bend radius of the power cable is 90 mm. When installing the cable, be sure to maintain sufficient distance from obstacles. In addition, leave enough space for other cables so that they are not bent forcibly.

Ensure distance to the safeguard from the maximum motion range is more than 100 mm.

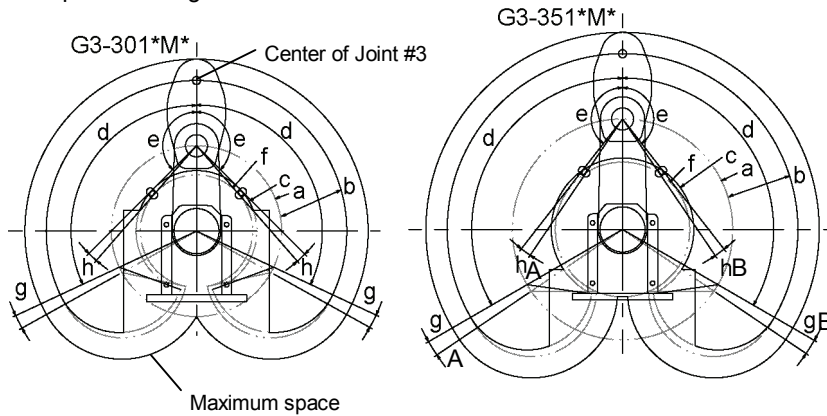
Table Top Mounting



	G3-251S/C	G3-301S/C		
		Standard	-R	-L
a Length of Arm #1 (mm)	120	170		
b Length of Arm #2 (mm)	130			
c (Motion range)	84 / 92	104.8 / 107.1	120.7	
	Z : 150/120			
d Motion range of Joint #1 (degree)	140	140	-125 to +150	-150 to +125
e Motion range of Joint #2 (degree)	141 / 137	142 / 141	-135 to +150 /-135 to +145	-150 to +135 /-145 to +135
f (Mechanical stop area)	79.3	104.8 / 107.1	96.2	86.8
g Joint #1 angle to hit mechanical stop (degree)	2	2	A:3 B:6	A:6 B:3
h Joint #2 angle to hit mechanical stop (degree)	2.3	3.8	A:8.3 B:3.3	A:3.3 B:8.3

		G3-351S/C		
		Standard	-R	-L
a	Length of Arm #1 (mm)	220		
b	Length of Arm #2 (mm)	130		
c	(Motion range)	142.3 / 146.6	191.6	
		Z : 150/120		
d	Motion range of Joint #1 (degree)	140	-110 to +165	-165 to +110
e	Motion range of Joint #2 (degree)	-142	-120 to +165 / -120 to+160	-165 to +120
f	(Mechanical stop area)	134.2	100.3 / 107.5	100.3 / 107.5
g	Joint #1 angle to hit mechanical stop (degree)	2	A:5 B:4	A:4 B:5
h	Joint #2 angle to hit mechanical stop (degree)	3.8	A:2.8 B:3.8 / A:7.8 B:3.8	A:3.8 B:2.8 / A:3.8 B:7.8

## Multiple Mounting



	G3-301SM/CM	G3-351SM/CM		
	Standard	Standard	-R	-L
a Length of Arm #1 (mm)	170	220	220	220
b Length of Arm #2 (mm)	130			
c (Motion range)	120.7	142.3	125.6 / 140.5	125.6 / 140.5
	Z : 150 / 120			
d Motion range of Joint #1 (degree)	115	120	-105 to +130	-130 to +105
e Motion range of Joint #2 (degree)	135	142	-120 to +160 / -120 to +150	-160 to +120 / -150 to +120
f (Mechanical stop area)	112	134.2	103.3 / 125.6	103.3 / 125.6
g Joint #1 angle to hit mechanical stop (degree)	4	4	A:3.3 B:5	A:5 B:3.3
h Joint #2 angle to hit mechanical stop (degree)	3.8	3.8	A:3.8 B:2.8	A:2.8 B:3.8

## 3.4 Unpacking and Transportation

THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.



**WARNING**

- Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.



**CAUTION**

- Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered.
- After removing the bolts securing the Manipulator to the delivery equipment, the Manipulator can fall. Be careful not to get hands or fingers caught.
- The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught.
- To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand. When holding the bottom of the base by hand, be very careful not to get your hands or fingers caught.

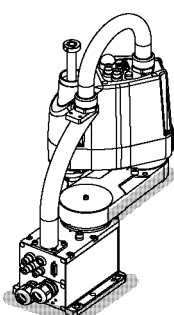
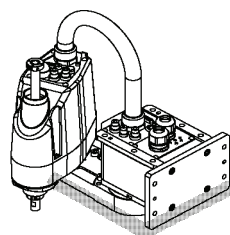


Table Top Mounting

G3-251S : approx. 27 kg: 60 lb.  
G3-301S : approx. 27 kg: 60 lb.  
G3-351S : approx. 28 kg: 62 lb.



Multiple Mounting

G3-301\*M : approx. 29 kg: 64 lb.  
G3-351\*M : approx. 29.5 kg: 65 lb

- Stabilize the Manipulator with your hands when hoisting it.
- When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls. If necessary, pack the Manipulator in the same style as it was delivered.

## 3.5 Installation Procedure

The following sections describe the installation of the Standard Manipulator.


### 3.5.1 Table Top Mounting

#### 3.5.2 Multiple Mounting

For Cleanroom-model manipulator, refer to this section;

#### 3.5.3 Cleanroom-model

### 3.5.1 Table Top Mounting

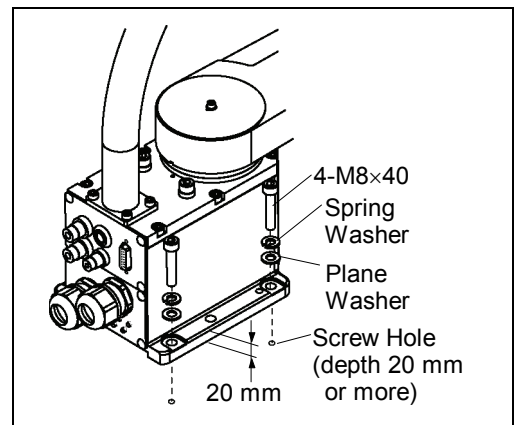
 <b>CAUTION</b>	<p>■ Install the Table Top Mounting Manipulator with two or more people.          The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.</p> <p>G3-251S : approx. 27 kg: 60 lb.          G3-301S : approx. 27 kg: 60 lb.          G3-351S : approx. 28 kg: 62 lb.</p>
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#### Standard-model

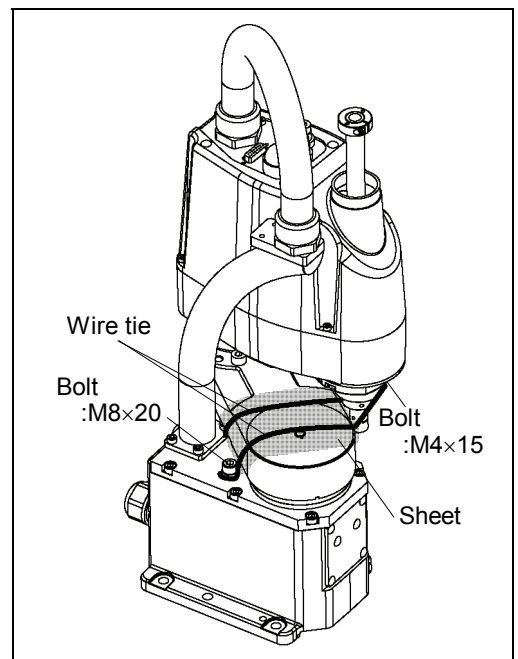
- (1) Secure the base to the base table with four bolts.




Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9.



- (2) Using nippers, cut off the wire tie binding the shaft and arm retaining bracket on the base.
- (3) Remove the bolts securing the wire ties removed in step (2).

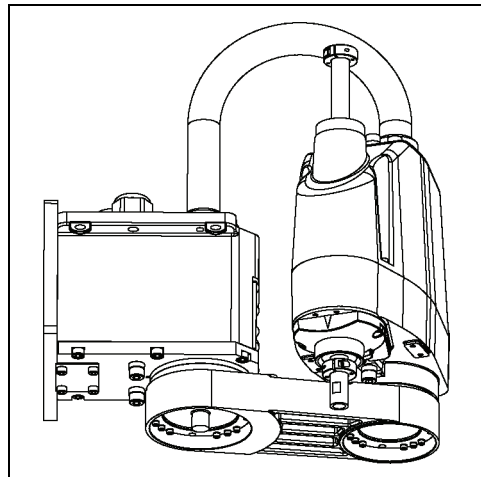


## 3.5.2 Multiple Mounting

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ Install the Multiple Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. G3-301*M : approx. 29 kg: 64 lb. G3-351*M : approx. 29.5 kg: 65 lb.</li> <li>■ When installing the Manipulator to the wall, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.</li> </ul>
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## Standard-model

- (1) Unpack the manipulator with retaining the arm posture.

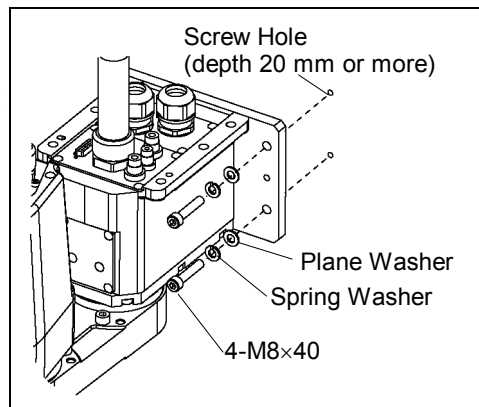


- (2) Secure the base to the wall with four bolts.

## NOTE




Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9.







### 3.5.3 Cleanroom-model

- (1) Unpack it outside of the clean room.
- (2) Secure the Manipulator to delivery equipment such as a pallet with bolts so that the Manipulator does not fall.
- (3) Wipe off the dust on the Manipulator with a little alcohol or distilled water on a lint-free cloth.
- (4) Carry the Manipulator in the clean room.
- (5) Refer to the installation procedure of each Manipulator model and install the Manipulator.
- (6) Connect an exhaust tube to the exhaust port.

 CAUTION	<ul style="list-style-type: none"> <li>■ When operating the Manipulator under special environmental conditions (adverse conditions with dust and oily smoke), do not place the controller in the same condition since the controller does not comply with IP54 / IP65. Doing so may cause equipment damage to and/or malfunction of the controller.</li> </ul>
--	--

## 3.6 Connecting the Cables

 WARNING	<ul style="list-style-type: none"> <li>■ To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.</li> <li>■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.</li> <li>■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.</li> </ul>
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 CAUTION	<ul style="list-style-type: none"> <li>■ When connecting the Manipulator to the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also serious safety problems. The connection method varies with the Controller used. For details on the connection, refer to the <i>Controller manual</i>. If the G series Manipulator or E2 series Manipulator is connected to the Controller for the PS series (ProSix), it may result in malfunction of the Manipulator.</li> </ul>
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When the Manipulator is a Cleanroom-model, be aware of the followings.

For the Manipulator of Cleanroom-model, use it with an exhaust system.

For details, refer to *Setup & Operation: 2.4 Specifications*.

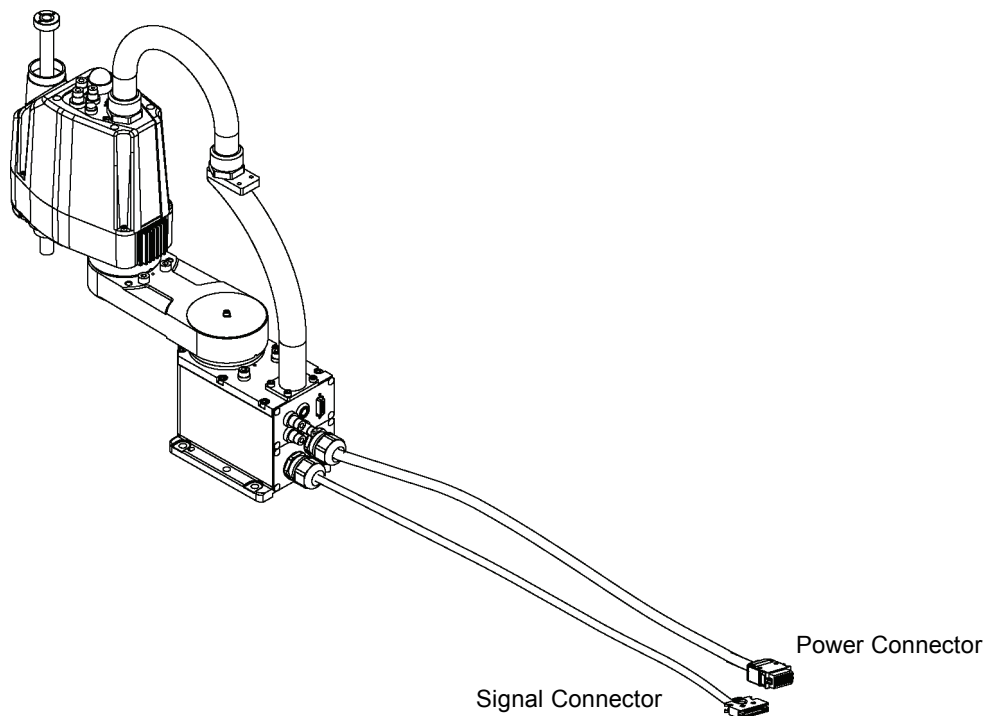


CAUTION

- When operating the Manipulator under special environmental conditions (adverse conditions with dust and oily smoke), do not place the controller in the same condition since the controller does not comply with IP54 / IP65. Doing so may cause equipment damage to and/or malfunction of the controller.

### Cable Connections

Connect the power connector and signal connector of the M/C cables to the Controller.



### 3.7 User Wires and Pneumatic Tubes



CAUTION

- Only authorized or certified personnel should be allowed to perform wiring. Wiring by unauthorized or uncertified personnel may result in bodily injury and/or malfunction of the robot system.

User electrical wires and pneumatic tubes are contained in the cable unit.

#### Electrical Wires

Rated Voltage	Allowable Current	Wires	Nominal Sectional Area	Outer Diameter	Note
AC/DC30 V	1 A	15	0.211 mm <sup>2</sup>	ø8.3±0.3 mm	Shielded

		Maker	Standard	
15 pin	Suitable Connector	JAE	DA-15PF-N	(Solder type)
	Clamp Hood	JAE	DA-C8-J10-F2-1R	(Connector setscrew: #4-40 NC)

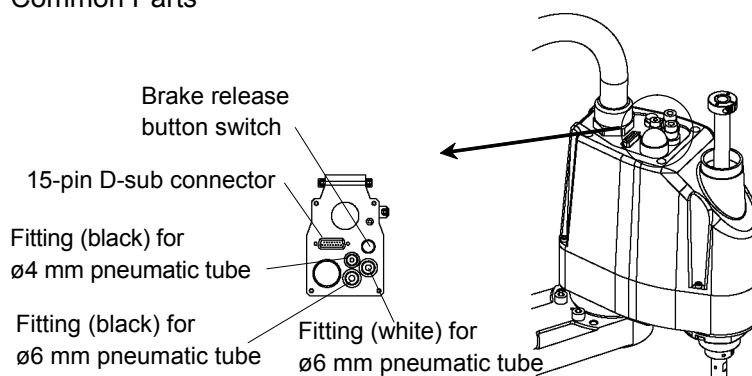
Pins with the same number, indicated on the connectors on both ends of the cables, are connected.

#### Pneumatic Tubes

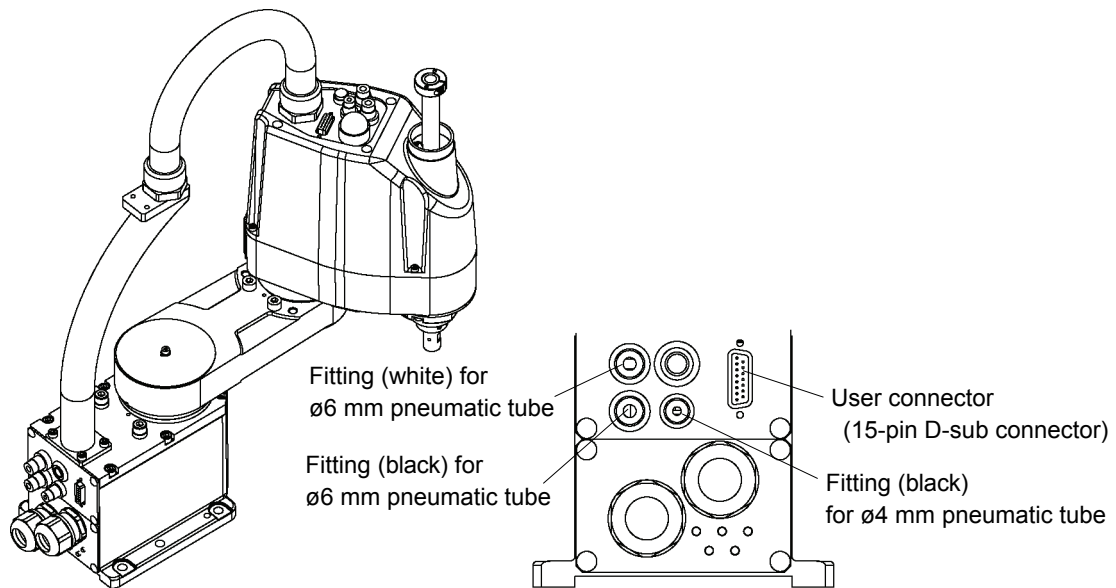
Max. Usable Pneumatic Pressure	Pneumatic Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm <sup>2</sup> : 86 psi)	2	ø6 mm × ø4 mm
	1	ø4 mm × ø2.5 mm

Fittings for ø6 mm and ø4 mm (outer diameter) pneumatic tubes are supplied on both ends of the pneumatic tubes.

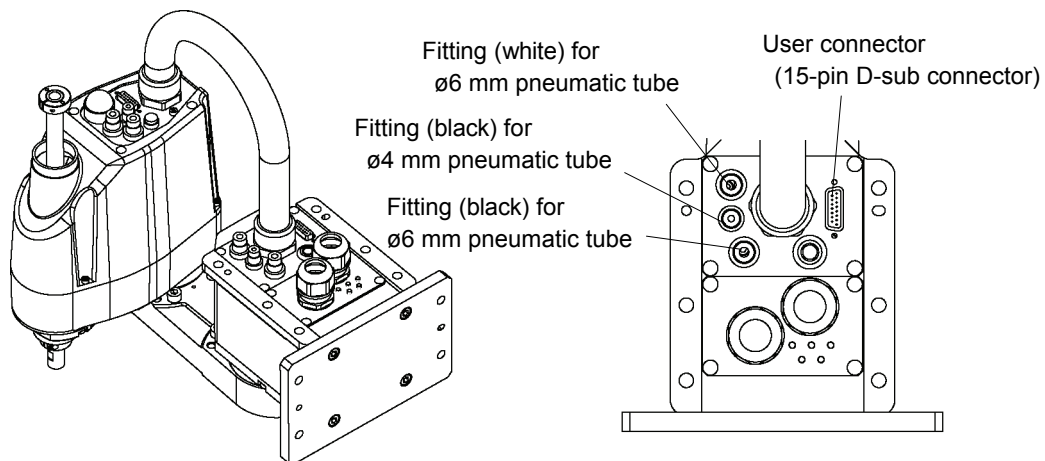
#### Common Parts



### Table Top Mounting



### Multiple Mounting





## 3.8 Relocation and Storage

### 3.8.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.

THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.</li> </ul>
 <b>CAUTION</b>	<ul style="list-style-type: none"> <li>Before relocating the Manipulator, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Manipulator.</li> <li>When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught.</li> <li>To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the bottom of Arm #1, the bottom of the main cable fitting, and the bottom of the base by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught.</li> <li>Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.</li> </ul>

When transporting the Manipulator for a long distance, secure it to the delivery equipment so that the Manipulator cannot fall.

If necessary, pack the Manipulator in the same way as it was delivered.

When the Manipulator is used for a robot system again after long-term storage, perform a test run to verify that it works properly, and then operate it thoroughly.


Transport and store the Manipulator in the range of -25°C to +55°C.


Humidity within 10% to 90% is recommended.

When condensation occurs on the Manipulator during transport or storage, turn ON the power only after the condensation dries.

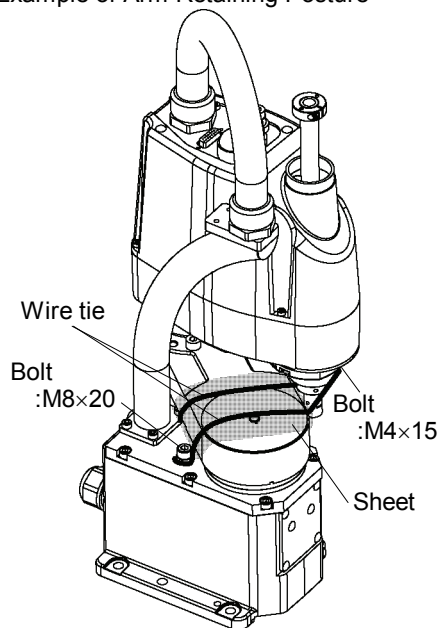
Do not shock or shake the Manipulator during transport.

## 3.8.2 Table Top Mounting

 CAUTION	<ul style="list-style-type: none"> <li>Install or relocate the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.  G3-251S : approx. 27 kg: 60 lb.  G3-301S : approx. 27 kg: 60 lb.  G3-351S : approx. 28 kg: 62 lb.</li> </ul>
--	---

NOTE  
 (1) Turn OFF the power on all devices and unplug the cables.  
Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to *Setup & Operation: 5.2 Motion Range Setting by Mechanical Stops*.

- (2) Cover the arm with a sheet so that the arm will not be damaged.  
Tie the lower end of the shaft and arm, and the base and arm together with a wire tie.  
Be careful not to tie them too tight. Otherwise, the shaft may bend.  
Example of Arm Retaining Posture




- (3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts.  
Then, remove the Manipulator from the base table.

## 3.8.3 Multiple Mounting

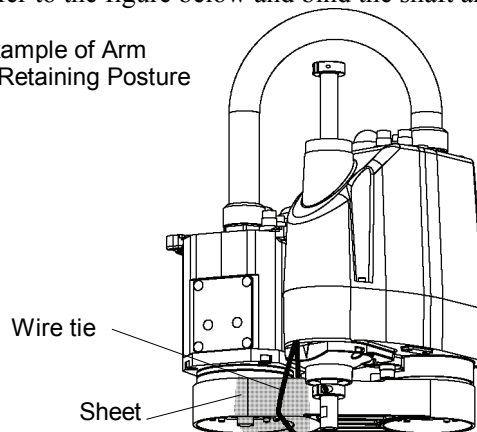


- Install or relocate the Multiple Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.  
G3-301\*M : approx. 29 kg: 64 lb.  
G3-351\*M : approx. 29.5 kg: 65 lb.
- When removing the Manipulator from the wall, support the Manipulator, and then remove the anchor bolts. Removing the anchor bolts without supporting is extremely hazardous and may result in fall of the Manipulator.

- NOTE  (1) Turn OFF the power on all devices and unplug the cables.  
Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to *Setup & Operation: 5.2 Motion Range Setting by Mechanical Stops*.

- (2) Cover the arm with a sheet so that the arm will not be damaged.  
Refer to the figure below and bind the shaft and arm retaining bracket on the base.

Example of Arm  
Retaining Posture




- (3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts. Then, remove the Manipulator from the wall.

## 4. Setting of End Effectors

### 4.1 Attaching an End Effector

Users are responsible for making their own end effector(s). Before attaching an end effector, observe these guidelines.

 <p>CAUTION</p>	<ul style="list-style-type: none"> <li>■ If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system and/or work piece as the work piece is released when the Emergency Stop switch is pressed. I/O outputs are configured at the factory so that they are automatically shut off (0) by power disconnection, the Emergency Stop switch, or the safety features of the robot system.</li> </ul>
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#### Shaft

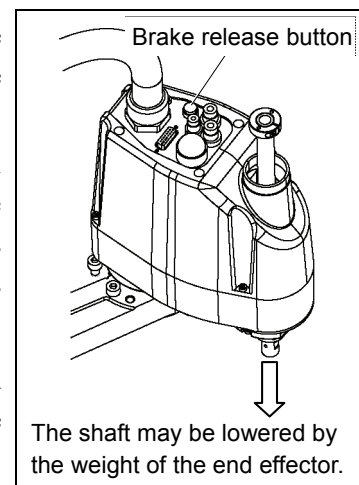
- Attach an end effector to the lower end of the shaft.  
For the shaft dimensions, and the overall dimensions of the Manipulator, refer to *Setup & Operation: 2. Specifications*.
- Do not move the upper limit mechanical stop on the lower side of the shaft. Otherwise, when “Jump motion” is performed, the upper limit mechanical stop may hit the Manipulator, and the robot system may not function properly.
- Use a split muff coupling with an M4 bolt or larger to attach the end effector to the shaft.

#### Brake release button

- Joint #3 cannot be moved up/down by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.

This prevents the shaft from hitting peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.

To move Joint #3 up/down while attaching an end effector, turn ON the Controller and press the brake release button.



This button switch is a momentary-type; the brake is released only while the button switch is being pressed.

- Be careful of the shaft while the brake release button is being pressed because the shaft may be lowered by the weight of the end effector.

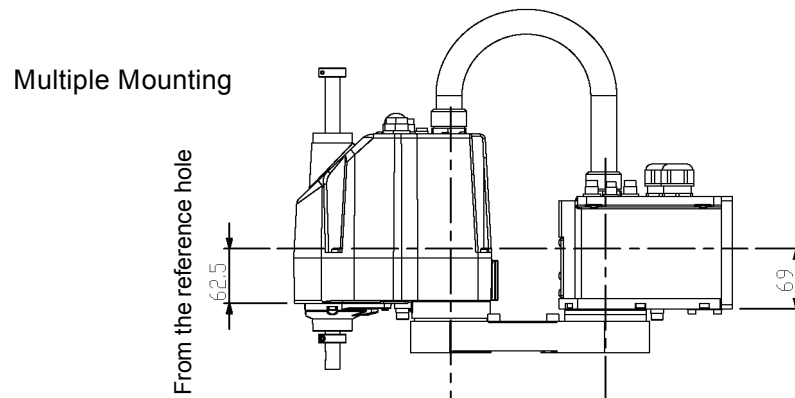
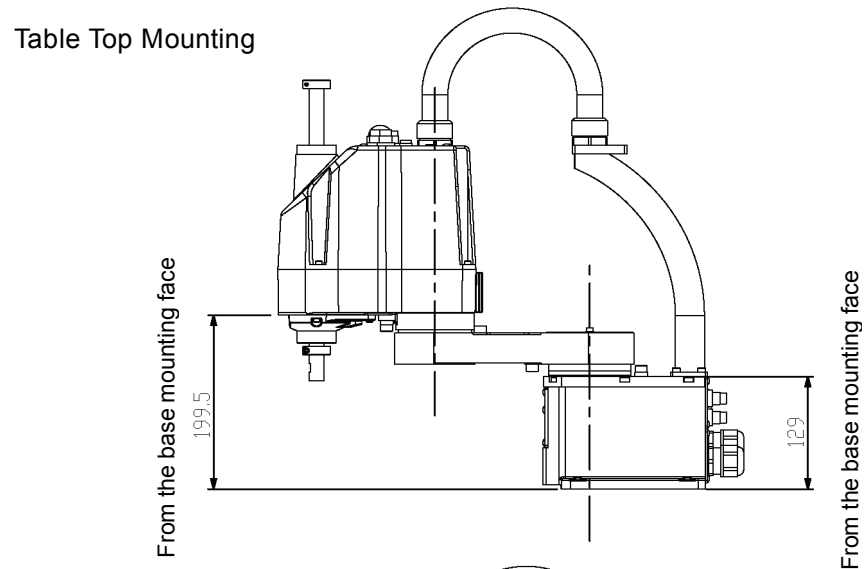
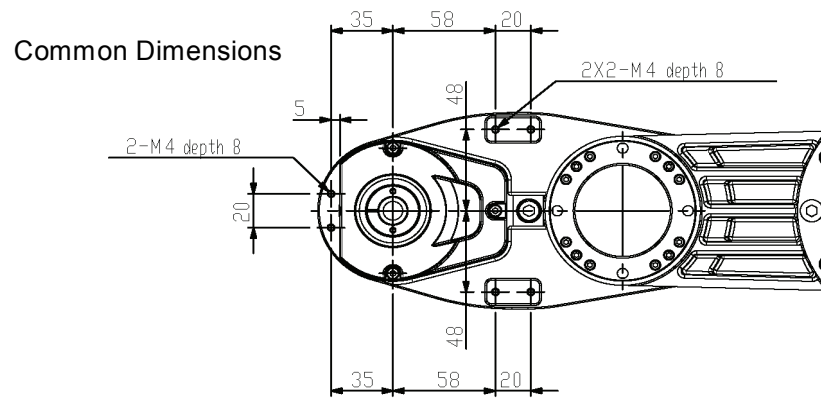
#### Layouts

- When you operate the manipulator with an end effector, the end effector may interfere with the Manipulator because of the outer diameter of the end effector, the size of the work piece, or the position of the arms. When designing your system layout, pay attention to the interference area of the end effector.



## 4.2 Attaching Cameras and Valves

Arm #2 has threaded holes as shown in the figure below. Use these holes for attaching cameras, valves, and other equipment. [Unit: mm]



## 4.3 Weight and Inertia Settings

To ensure optimum Manipulator performance, it is important to make sure that the load (weight of the end effector and work piece) and moment of inertia of the load are within the maximum rating for the Manipulator, and that Joint #4 does not become eccentric.

If the load or moment of inertia exceeds the rating or if the load becomes eccentric, follow the steps below, “4.3.1 Weight Setting” and “4.3.2 Inertia Setting” to set parameters.

Setting parameters makes the PTP motion of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the moment of inertia of the end effector and work piece is larger than the default setting.

### 4.3.1 Weight Setting



CAUTION

- The total weight of the end effector and the work piece must not exceed 3 kg. The G3 series Manipulators are not designed to work with loads exceeding 3 kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable weight capacity (end effector and work piece) in G3 series is 1 kg at the default rating and 3 kg at the maximum. When the load (weight of the end effector and work piece) exceeds the rating, change the setting of Weight parameter.

After the setting is changed, the maximum acceleration/deceleration speed of the robot system at PTP motion corresponding to the “Weight Parameter” is set automatically.

#### Load on the Shaft

The load (weight of the end effector and work piece) on the shaft can be set by Weight parameter.

EPSON  
RC+

Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools] - [Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

#### Load on the Arm

When you attach a camera or other devices to the arm, calculate the weight as the equivalent of the shaft. Then, add this to the load and enter the total weight to the Weight parameter.

#### Equivalent Weight Formula

When you attach the equipment near Arm #2:  $W_M = M (L_1)^2 / (L_1 + L_2)^2$

When you attach the equipment to the end of Arm #2:  $W_M = M (L_M)^2 / (L_2)^2$

$W_M$  : equivalent weight

$M$  : weight of camera etc.

$L_1$  : length of Arm #1

$L_2$  : length of Arm #2

$L_M$  : distance from rotation center of Joint #2 to center of gravity of camera etc.

<Example> A “1 kg” camera is attached to the end of the G3 series arm (180 mm away from the rotation center of Joint #2) with a load weight of “1 kg”.

$$M = 1$$

$$L_2 = 130$$

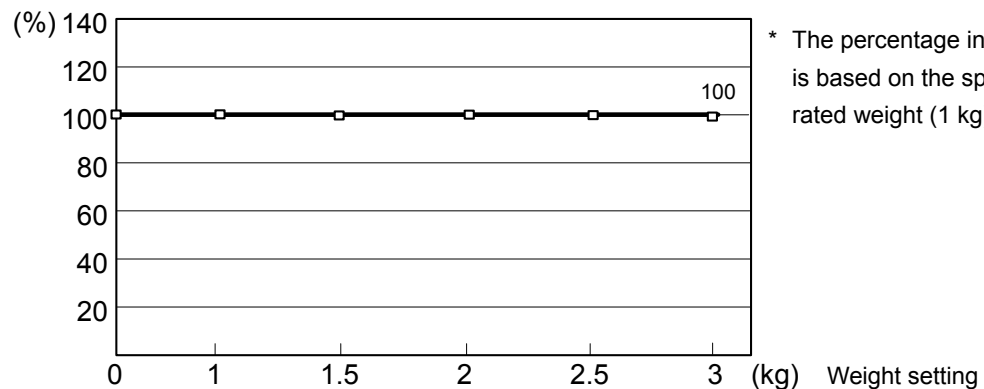
$$L_M = 180$$

$$W_M = 1 \times 180^2 / 130^2 = 1.538 \rightarrow 1.6 \text{ (round up)}$$

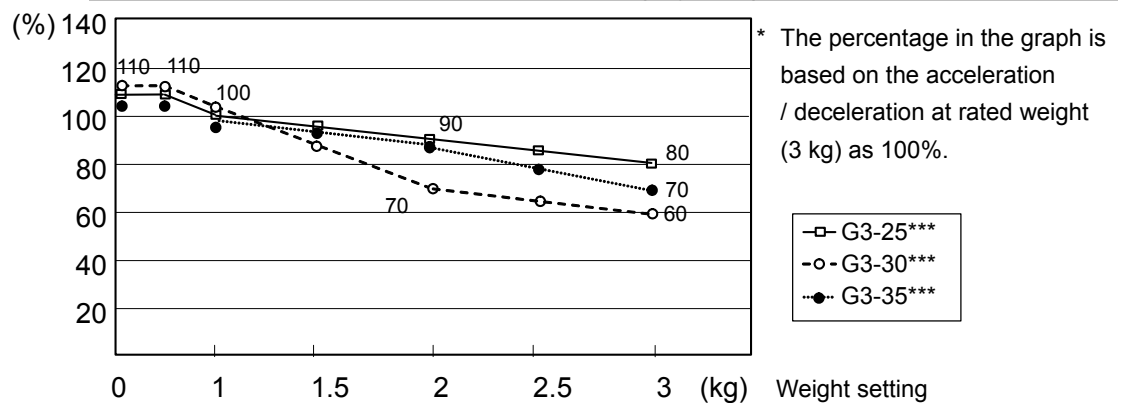
$$W + W_M = 1 + 1.6 = 2.6$$

Enter “2.6” for the Weight Parameter.

Automatic speed setting by Weight



Automatic acceleration/deceleration setting by Weight



### 4.3.2 Inertia Setting

#### Moment of Inertia and the Inertia Setting

The moment of inertia is defined as “the ratio of the torque applied to a rigid body and its resistance to motion”. This value is typically referred to as “the moment of inertia”, “inertia”, or “GD<sup>2</sup>”. When the Manipulator operates with additional objects (such as an end effector) attached to the shaft, the moment of inertia of load must be considered.



CAUTION

- The moment of inertia of the load (weight of the end effector and work piece) must be 0.05 kg·m<sup>2</sup> or less. The G3 series Manipulators are not designed to work with a moment of inertia exceeding 0.05 kg·m<sup>2</sup>. Always set the moment of inertia parameter to the correct moment of inertia. Setting a value that is smaller than the actual moment of inertia may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable moment of inertia of load for a G3 series Manipulator is 0.005 kg·m<sup>2</sup> at the default rating and 0.05 kg·m<sup>2</sup> at the maximum. When the moment of inertia of the load exceeds the rating, change the setting of the moment of inertia parameter of the Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of Joint #4 at PTP motion corresponding to the “moment of inertia” value is set automatically.

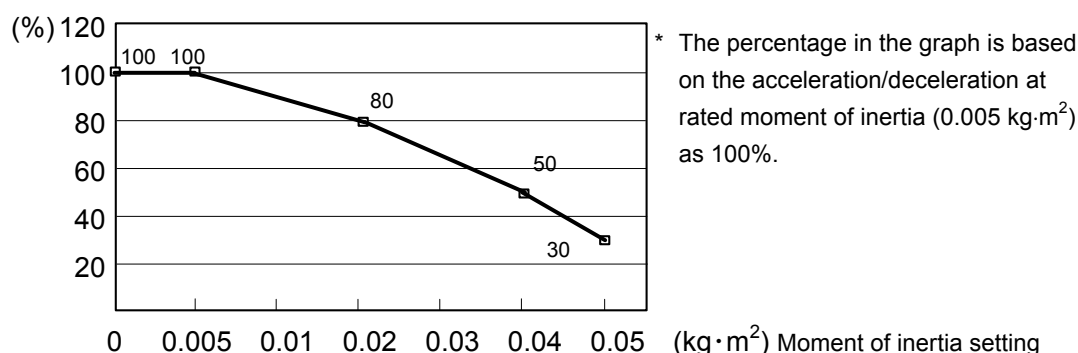
#### Moment of inertia of load on the shaft

The moment of inertia of load (weight of the end effector and work piece) on the shaft can be set by the “moment of inertia” parameter of the Inertia command.

EPSON  
RC+

Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools] - [Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

#### Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia)

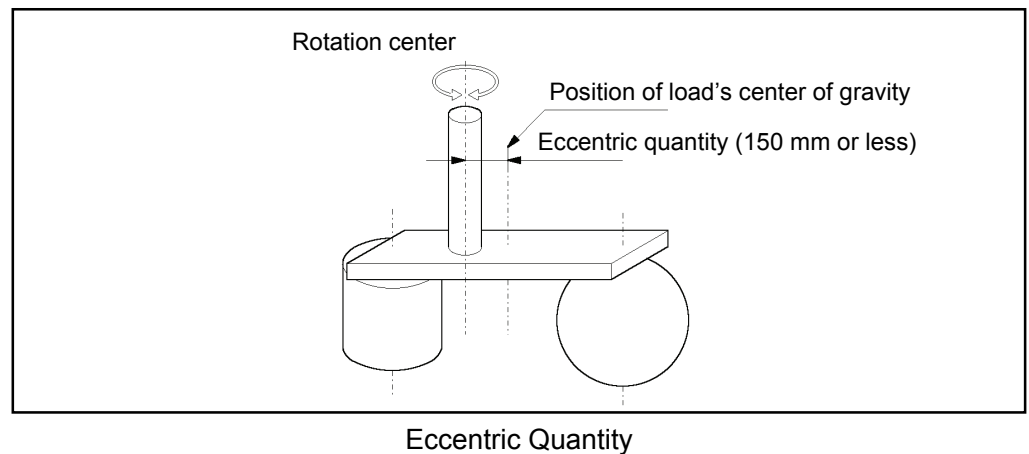


## Eccentric Quantity and the Inertia Setting



- The eccentric quantity of load (weight of the end effector and work piece) must be 150 mm or less. The G3 series Manipulators are not designed to work with eccentric quantity exceeding 150 mm. Always set the eccentric quantity parameter according to the eccentric quantity. Setting a value that is smaller than the actual eccentric quantity may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable eccentric quantity of load in G3 series is 0 mm at the default rating and 150 mm at the maximum. When the eccentric quantity of load exceeds the rating, change the setting of eccentric quantity parameter of Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of the Manipulator at PTP motion corresponding to the “eccentric quantity” is set automatically.



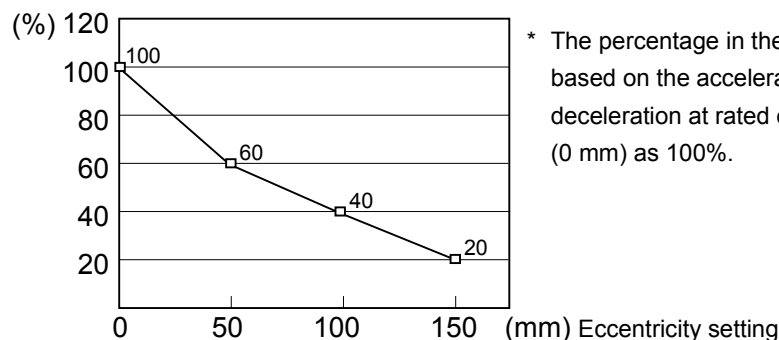
## Eccentric quantity of load on the shaft

The eccentric quantity of load (weight of the end effector and work piece) on the shaft can be set by “eccentric quantity” parameter of Inertia command.

EPSON  
RC+

Enter a value into the [Eccentricity:] text box on the [Inertia] panel ([Tools] - [Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

## Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

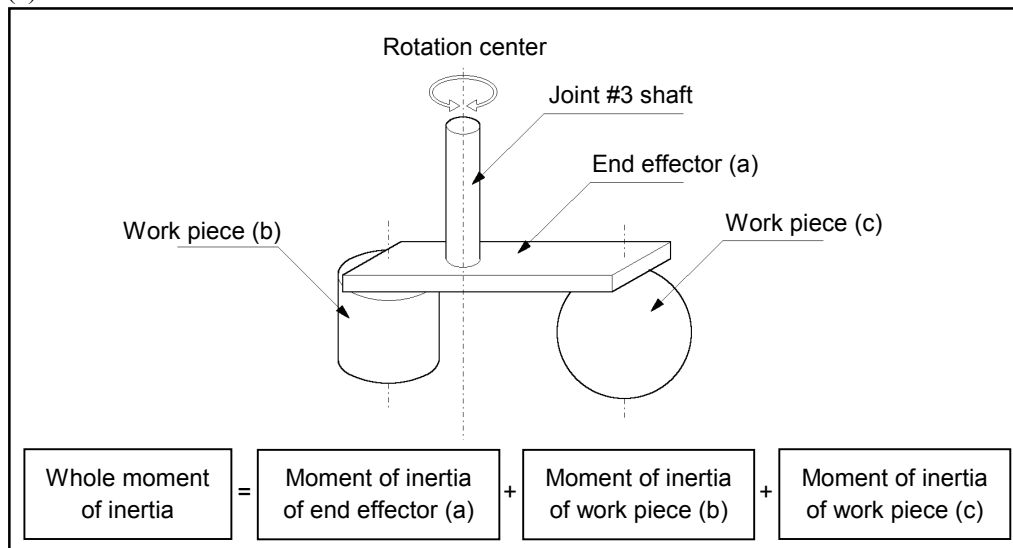


\* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

### Calculating the Moment of Inertia

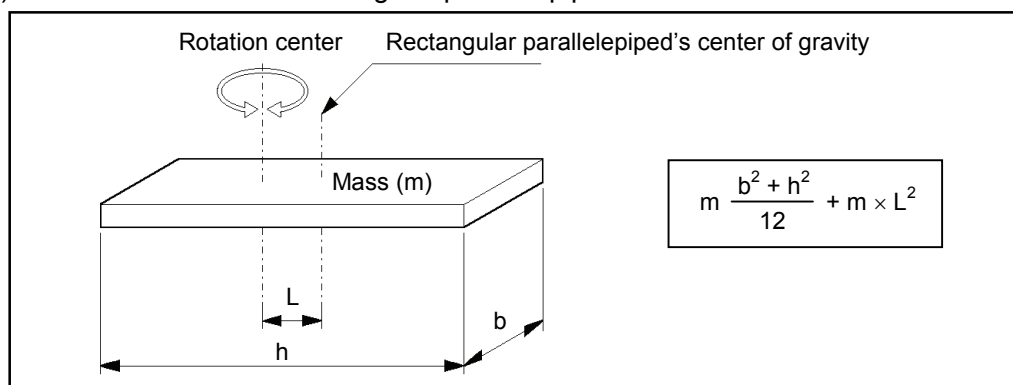
Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece).

The moment of inertia of the entire load is calculated by the sum of each part (a), (b), and (c).

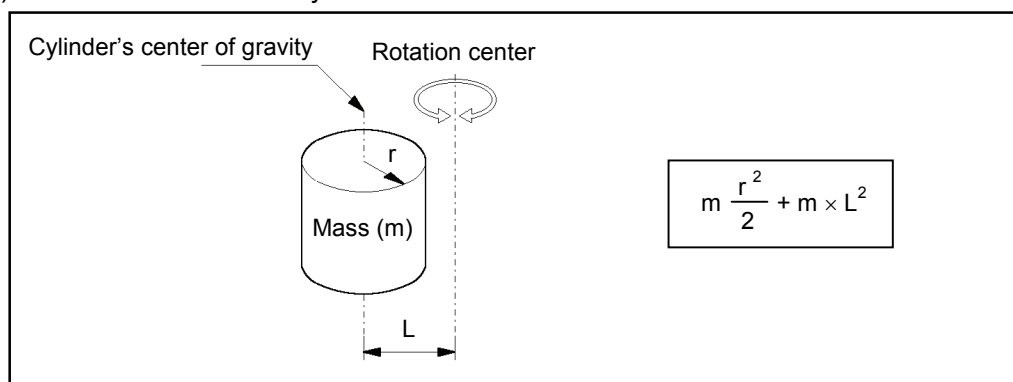


The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.

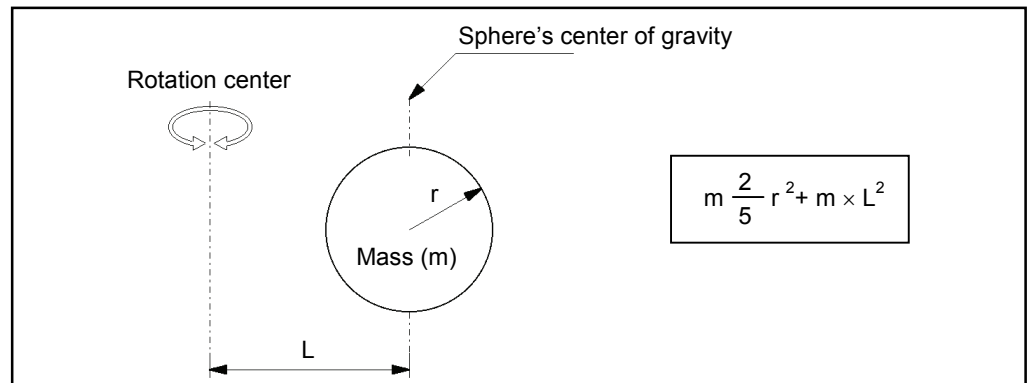
#### (a) Moment of inertia of a rectangular parallelepiped



#### (b) Moment of inertia of a cylinder



## (c) Moment of inertia of a sphere



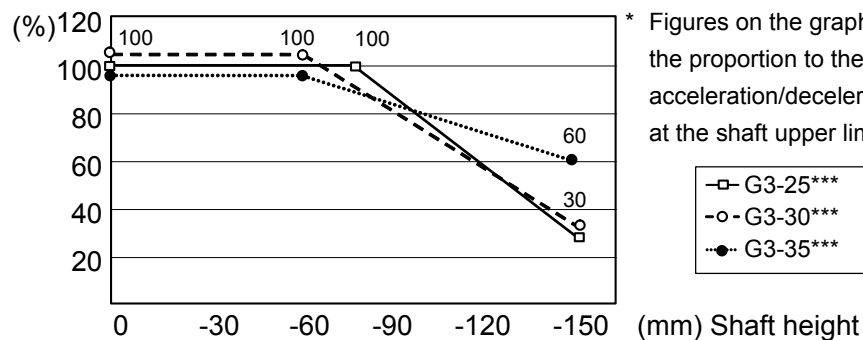
## 4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

When you move the Manipulator in horizontal PTP motion with Joint #3 (Z) at a high position, the motion time will be faster.

When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figure below.) The higher the position of the shaft is, the faster the motion acceleration/deceleration is. However, it takes more time to move Joint #3 up and down. Adjust the position of Joint #3 for the Manipulator motion after considering the relation between the current position and the destination position.

The upper limit of Joint #3 during horizontal motion using Jump command can be set by the LimZ command.

Automatic acceleration/deceleration vs. Joint #3 position



\* Figures on the graph (%) are the proportion to the acceleration/deceleration speed at the shaft upper limit position.



NOTE When moving the Manipulator horizontally while the shaft is being lowered, it may cause over-shoot at the time of final positioning.

## 5. Motion Range



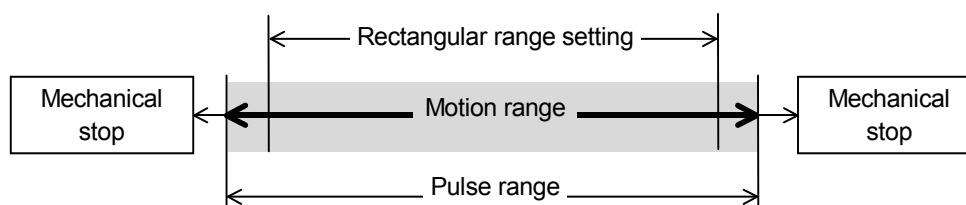
CAUTION

- When setting up the motion range for safety, both the pulse range and mechanical stops must always be set at the same time.

The motion range is preset at the factory as explained in *Setup & Operation: 5.4 Standard Motion Range*. That is the maximum motion range of the Manipulator.

There are three methods for setting the motion range described as follows:

1. Setting by pulse range (for all joints)
2. Setting by mechanical stops (for Joints #1 to #3)
3. Setting the Cartesian (rectangular) range in the X, Y coordinate system of the Manipulator (for Joints #1 and #2)



When the motion range is changed due to layout efficiency or safety, follow the descriptions in 5.1 to 5.3 to set the range.



## 5.1 Motion Range Setting by Pulse Range (for All Joints)

Pulses are the basic unit of Manipulator motion. The motion range of the Manipulator is controlled by the pulse range between the pulse lower limit and upper limit of each joint. Pulse values are read from the encoder output of the servo motor.

For the maximum pulse range, refer to the following sections.

The pulse range must be set inside of the mechanical stop range.

*5.1.1 Max. Pulse Range of Joint #1*

*5.1.2 Max. Pulse Range of Joint #2*

*5.1.3 Max. Pulse Range of Joint #3*

*5.1.4 Max. Pulse Range of Joint #4.*



Once the Manipulator receives an operating command, it checks whether the target position specified by the command is within the pulse range before operating. If the target position is out of the set pulse range, an error occurs and the Manipulator does not move.



The pulse range can be set on the [Range] panel shown by selecting [Tools]-[Robot Manager]. (You may also execute the Range command from the [Command Window].)

### 5.1.1 Max. Pulse Range of Joint #1

The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis.

When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (-).

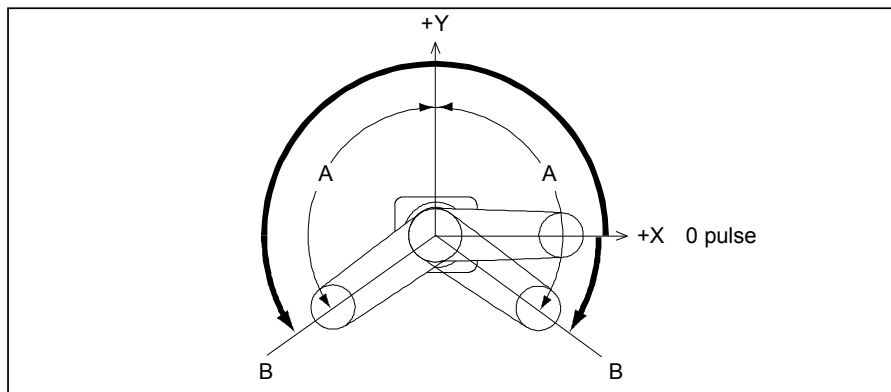


Table Top Mounting

	Arm	Standard	-R	-L
A Max. Motion Range	25	$\pm 140 / \pm 140$	—	—
	30		-125 ~ 150 / -125 ~ 150	-150 ~ 125 / -150 ~ 125
	35		-110 ~ 165 / -110 ~ 165	-165 ~ 110 / -165 ~ 110
B Max. Pulse Range	25	-1456356 ~ 6699236 / -1456356 ~ 6699236	—	—
	30		-1019449 ~ 6990507 / -1019449 ~ 6990507	-1747627 ~ 6262329 / -1747627 ~ 6262329
	35		-582542 ~ 7427413 / -582542 ~ 7427413	-2184533 ~ 5825422 / -2184533 ~ 5825422

Multiple Mounting

	Arm	Standard	-R	-L
A Max. Motion Range	30	$\pm 115 / \pm 115$	—	—
	35	$\pm 120 / \pm 120$	-105 ~ 130 / -105 ~ 130	-130 ~ 105 / -130 ~ 105
B Max. Pulse Range	30	-728178 ~ 5971058 / -728178 ~ 5971058	—	—
	35	-873813 ~ 6116693 / -873813 ~ 6116693	-436907 ~ 6407965 / -436907 ~ 6407965	-1165085 ~ 5679787 / -1165085 ~ 5679787

### 5.1.2 Max. Pulse Range of Joint #2

The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1. With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (-).

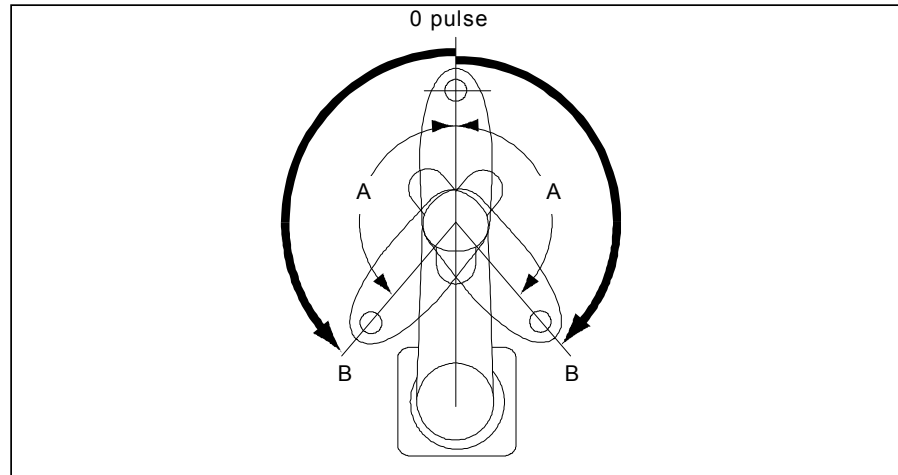


Table Top Mounting

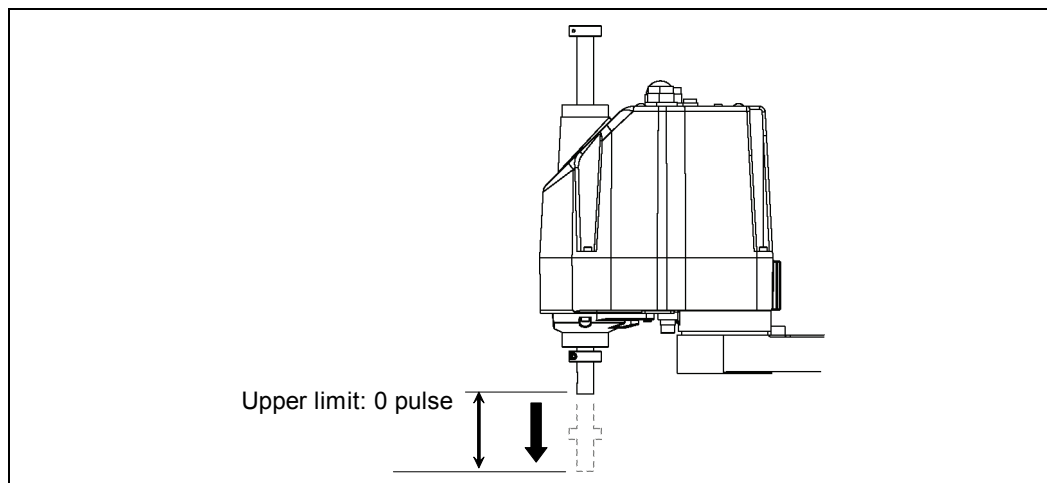
	Arm	Standard	-R	-L
A Max. Motion Range	25	$\pm 141 / \pm 137$	—	—
	30	$\pm 142 / \pm 141$	$-135 \sim 150 / -135 \sim 145$	$-150 \sim 135 / -145 \sim 135$
	35	$\pm 142 / \pm 142$	$-120 \sim 165 / -120 \sim 160$	$-165 \sim 120 / -160 \sim 120$
B Max. Pulse Range	25	$-2566827 \sim 2566827$ $/ -2494009 \sim 2494009$	—	—
	30	$-2585031 \sim 2585031$ $/ -2494009 \sim 2494009$	$-2457600 \sim 2730667$ $/ -2457600 \sim 2639645$	$-2730667 \sim 2457600$ $/ -2639645 \sim 2457600$
	35	$-2585031 \sim 2585031$ $/ 2585031 \sim 2585031$	$-2184533 \sim 3003733$ $/ -2184533 \sim 2912711$	$-3003733 \sim 2184533$ $/ -2912711 \sim 2184533$

Table Top Mounting

	Arm	Standard	-R	-L
A Max. Motion Range	30	$\pm 135 / \pm 135$	—	—
	35	$\pm 142 / \pm 142$	$-120 \sim 160 / -120 \sim 150$	$-160 \sim 120 / -150 \sim 120$
B Max. Pulse Range	30	$-2457600 \sim 2457600$ $/ -2457600 \sim 2457600$	—	—
	35	$-2585031 \sim 2585031$ $/ -2585031 \sim 2585031$	$-2184533 \sim 2912711$ $/ -2184533 \sim 2730667$	$-2912711 \sim 2184533$ $/ -2730667 \sim 2184533$

### 5.1.3 Max. Pulse Range of Joint #3

The 0 (zero) pulse position of Joint #3 is the position where the shaft is at its upper limit. The pulse value is always negative because Joint #3 always moves lower than the 0 pulse position.



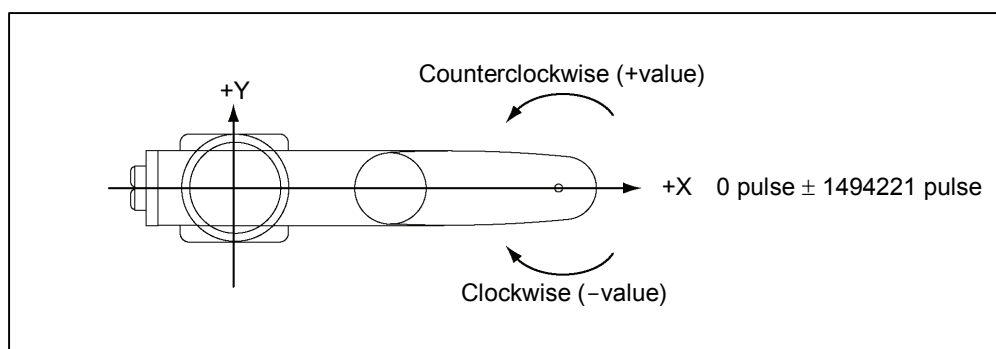
Model	Joint #3 Stroke	Lower Limit Pulse
G3-**1S*	150 mm	-1706667
G3-**C* (Cleanroom-model)	120 mm	-1365334



For the Cleanroom-model (G3-\*\*\*C\*), the motion range set with the Joint #3 mechanical stop cannot be changed.

### 5.1.4 Max. Pulse Range of Joint #4

The 0 (zero) pulse position of Joint #4 is the position where the flat near the end of the shaft faces toward the end of Arm #2. With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (-).



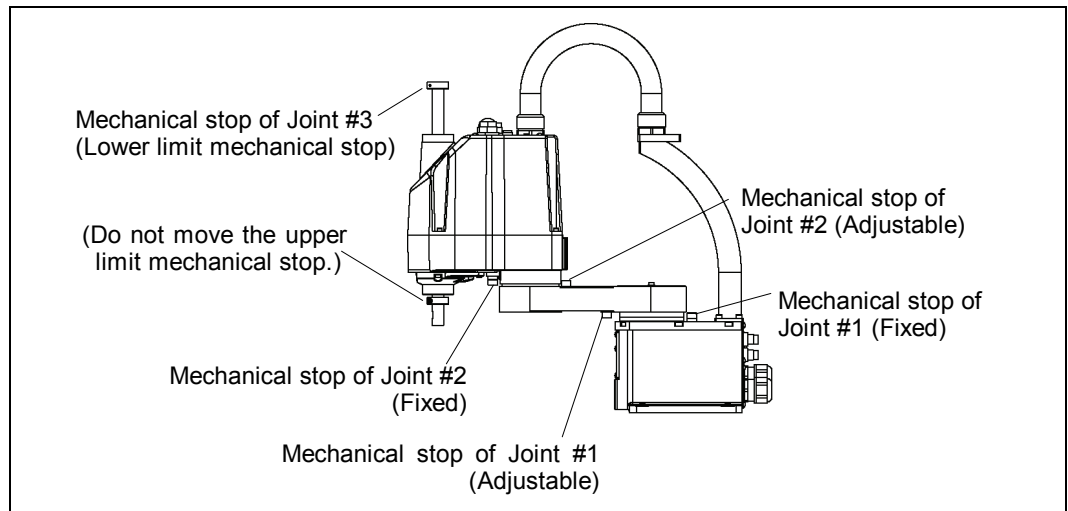
## 5.2 Motion Range Setting by Mechanical Stops

Mechanical stops physically limit the absolute area that the Manipulator can move.

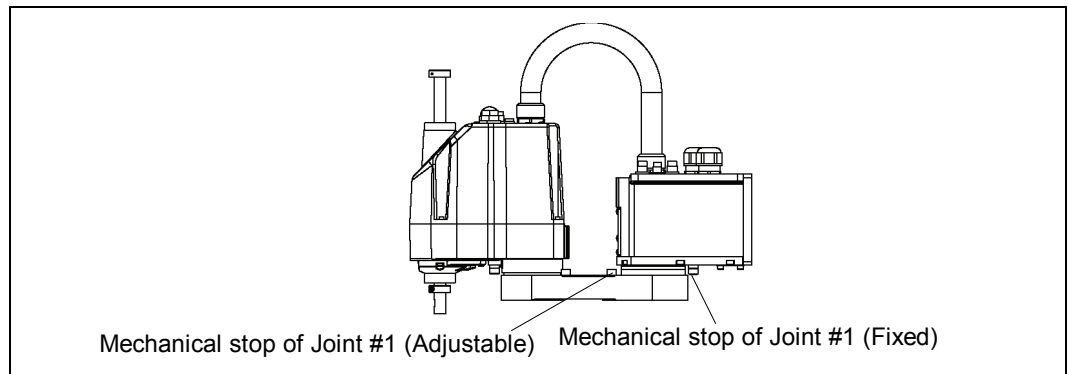
Both Joints #1 and #2 have threaded holes in the positions corresponding to the angle for the mechanical stop settings. Install the bolts in the holes corresponding to the angle that you want to set.

Joints #3 can be set to any length less than the maximum stroke.

### Table Top Mounting



### Multiple Mounting

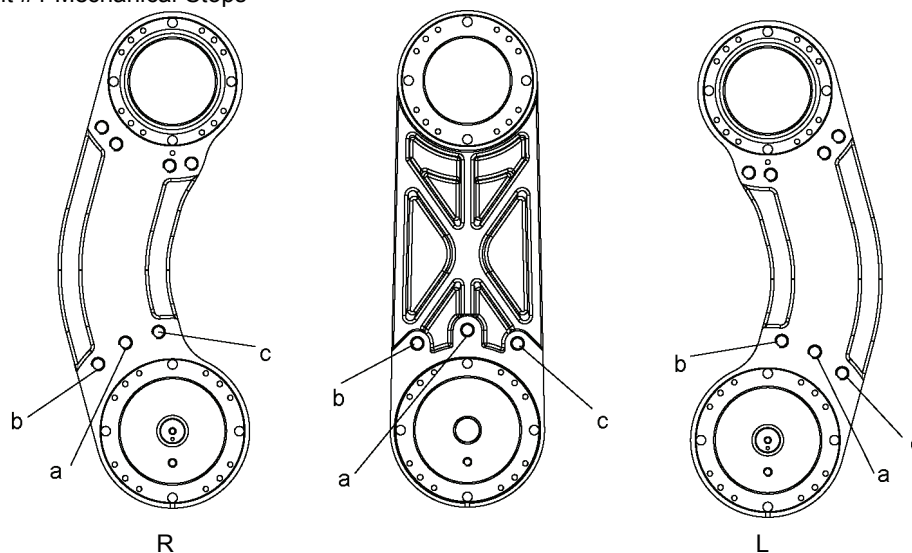


\* The different mechanical stop positions from Table Top mounting are indicated for Multiple mounting.

### 5.2.1 Setting the Mechanical Stops of Joints #1 and #2

Both Joints #1 and #2 have threaded holes in the positions corresponding to the angle for the mechanical stop settings. Install the bolts in the holes corresponding to the angle that you want to set.

Joint #1 Mechanical Stops



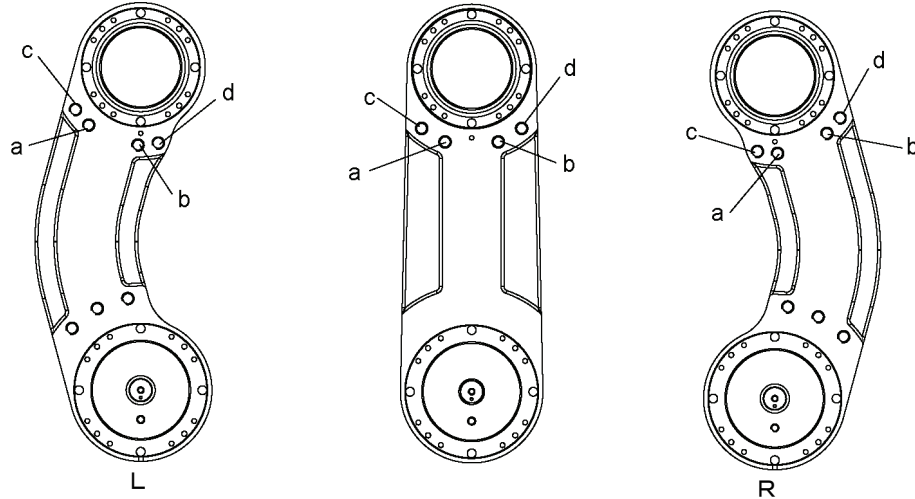
Views from the bottom of Arm #1

Model	Arm	a	b	c
G3-**1S/C	250	$\pm 140^\circ$	$-110^\circ$	$+110^\circ$
	300	$\pm 140^\circ$	$-110^\circ$	$+110^\circ$
	350	$\pm 140^\circ$	$-110^\circ$	$+110^\circ$
G3-**1S/C-R	300	$-125^\circ \sim +150^\circ$	$-105^\circ$	$+130^\circ$
	350	$-110^\circ \sim +165^\circ$	$-90^\circ$	$+145^\circ$
G3-**1S/C-L	300	$-150^\circ \sim +125^\circ$	$-130^\circ$	$+105^\circ$
	350	$-165^\circ \sim +110^\circ$	$-145^\circ$	$+90^\circ$
G3-**1SM/CM	300	$\pm 115^\circ$	$-85^\circ$	$+85^\circ$
	350	$\pm 120^\circ$	$-90^\circ$	$+90^\circ$
G3-**1SM/CM-R	300	$-130^\circ \sim +105^\circ$	$-100^\circ$	$+75^\circ$
	350	$-105^\circ \sim +130^\circ$	$-75^\circ$	$+100^\circ$

Setting Angle	$+75^\circ$	$+85^\circ$	$+90^\circ$	$+100^\circ$	$+105^\circ$	$+110^\circ$
Pulse Value	2184533	2475805	2621440	2912711	3058347	3203982
Setting Angle	$+140^\circ$	$+145^\circ$	$+150^\circ$	$+165^\circ$		
Pulse Value	4077796	4223431	4369067	4805973		
Setting Angle	$-75^\circ$	$-85^\circ$	$-90^\circ$	$-100^\circ$	$-105^\circ$	$-110^\circ$
Pulse Value	-2184533	-2475805	-2621440	-2912711	-3058347	-3203982
Setting Angle	$-140^\circ$	$-145^\circ$	$-150^\circ$	$+165^\circ$		
Pulse Value	-4077796	-4223431	-4369067	-4805973		

(°: degree)

Joint #2 Mechanical Stops



Views from the top of Arm #1

Model	Arm	a	b	c	d
G3-**1S/C	250	+141°	-141°	+120°	-120°
	300	+142°	-142°	+122°	-122°
	350	+142°	-142°	+122°	-122°
G3-**1S/C-R	300	+150°	-135°	+135°	-120°
	350	+165°	-120°	+150°	-105°
G3-**1S/C-L	300	+135°	-150°	+120°	-135°
	350	+120°	-165°	+105°	-150°
G3-**1SM/CM	300	+135°	-135°	+115°	-115°
	350	+142°	-142°	+122°	-122°
G3-**1SM/CM-R	300	+120°	-160°	+100°	-140°
	350	+160°	-120°	+140°	-120°

Setting Angle	+100°	+105°	+115°	+120°	+122°	+135°
Pulse Value	2912711	3058347	3349618	3495253	3553508	3932160
Setting Angle	+141°	+142°	+150°	+160°	+165°	
Pulse Value	4106923	4136050	4369067	4660338	4805973	
Setting Angle	-100°	-105°	-115°	-120°	-122°	-135°
Pulse Value	-2912711	-3058347	-3349618	-3495253	-3553508	-3932160
Setting Angle	-141°	-142°	-150°	-160°	-165°	
Pulse Value	-4106923	-4136050	-4369067	-4660338	-4805973	

(°: degree)



In case of Multiple Mounting, it is impossible to limit the operating range completely. Because it may hit the wall within the setting range of mechanical stops.

- (1) Turn OFF the Controller.
- (2) Install a hexagon socket head cap bolt into the hole corresponding to the setting angle, and tighten it.

Joint	Hexagon socket head cap bolt (fully threaded)	The number of bolts	Recommended tightening torque
1	M8 × 10	1 bolt / one side	3720 N·cm (380 kgf·cm)

- (3) Turn ON the Controller.
- (4) Set the pulse range corresponding to the new positions of the mechanical stops.



Be sure to set the pulse range inside the positions of the mechanical stop range.

Example: Using G3-251S\*

The angle of Joint #1 is set from -132 degrees to +132 degrees.

The angle of Joint #2 is set from -141 degrees to +141 degrees.

**EPSON  
RC+**

Execute the following commands from the [Command Window].

```
>JRANGE 1, -9786710, 51729750      ' Sets the pulse range of Joint #1
>JRANGE 2, -20534614, +20534614    ' Sets the pulse range of Joint #2
>RANGE                               ' Checks the setting using Range
-9786710, 51729750, -20534614, 20534614, -13653338
, 0, 23907534, 23907534
```

- (5) Move the arm by hand until it touches the mechanical stops, and make sure that the arm does not hit any peripheral equipment during operation.
- (6) Operate the joint changed at low speeds until it reaches the positions of the minimum and maximum pulse range. Make sure that the arm does not hit the mechanical stops. (Check the position of the mechanical stop and the motion range you set.)

Example: Using G3-251S\*

The angle of Joint #1 is set from -132 degrees to +132 degrees.

The angle of Joint #2 is set from -141 degrees to +141 degrees.

**EPSON  
RC+**

Execute the following commands from the [Command Window].

```
>MOTOR ON                          'Turns ON the motor
>CP ON                             'Enters low-power mode
>SPEED 5                           'Sets at low speeds
>PULSE -9786710, 0, 0, 0           'Moves to the min. pulse position of Joint #1
>PULSE 51729750, 0, 0, 0          'Moves to the max. pulse position of Joint #1
>PULSE 20971520, -20534614, 0, 0  'Moves to the min. pulse position of Joint #2
>PULSE 20971520, 20534614, 0, 0   'Moves to the max. pulse position of Joint #2
```

The Pulse command (Go Pulse command) moves all joints to the specified positions at the same time. Specify safe positions after considering motion of not only the joints whose pulse range have been changed, but also other joints.

In this example, Joint #1 is moved to the center of its motion range (pulse value: 20971520) when checking Joint #2.

If the arm is hitting the mechanical stops or if an error occurs after the arm hits the mechanical stops, either reset the pulse range to a narrower setting or extend the positions of the mechanical stops within the limit.



### 5.2.2 Setting the Mechanical Stop of Joint #3



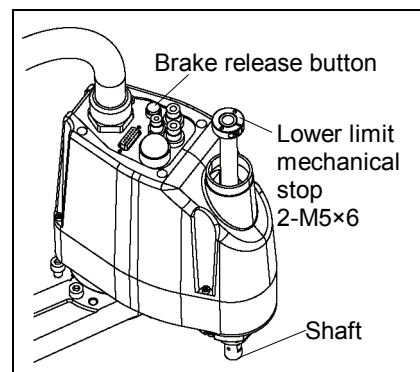
This method applies only to the Standard-model Manipulator (G3-\*\*1S\*) / Multiple Mounting Manipulator (G3-\*\*1SM).

For the Cleanroom-model (G3-\*\*1C\*), the motion range set with the Joint #3 mechanical stop cannot be changed.

(1) Turn ON the Controller and turn OFF the motors using the Motor OFF command.

(2) Push up the shaft while pressing the brake release button.

Do not push the shaft up to its upper limit or it will be difficult for the arm top cover to be removed. Push the shaft up to a position where the Joint #3 mechanical stop can be changed.



When you press the brake release button, the shaft may lower due to the weight of the end effector. Be sure to hold the shaft by hand while pressing the button.

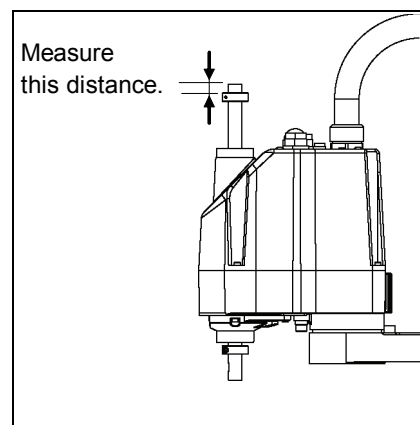
(3) Turn OFF the Controller.

(4) Loosen the lower limit mechanical stop screw (M4×15).



A mechanical stop is mounted on both the top and bottom of Joint #3. However, only the position of the lower limit mechanical stop on the top can be changed. Do not remove the upper limit mechanical stop on the bottom because the calibration point of Joint #3 is specified using the stop.

(5) The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke. For example, when the lower limit mechanical stop is set at “150 mm” stroke, the lower limit Z coordinate value is “-150”. To change the value to “-130”, move the lower limit mechanical stop down “20 mm”. Use calipers to measure the distance when adjusting the mechanical stop.



(6) Firmly tighten two lower limit mechanical stop screws (M4 × 15) so that they do not enter the shaft groove.

Recommended tightening torque: 490 N·cm (50 kgf·cm)

(7) Turn ON the Controller.

- (8) Move Joint #3 to its lower limit while pressing the brake release button, and then check the lower limit position. Do not lower the mechanical stop too far. Otherwise, the joint may not reach a target position.
- (9) Calculate the lower limit pulse value of the pulse range using the formula shown below and set the value.

The result of the calculation is always negative because the lower limit Z coordinate value is negative.

$$\text{Lower limit of pulse} = \text{lower limit Z coordinate value} / 25 \times 4096 \times 1.8$$

Example: When lowering the mechanical stop by 20 mm and changing the lower limit Z coordinate value to “-130” in 150 mm stroke  
 $(-130) / 25 \times 4096 \times 1.8 = -38339$

EPSON  
RC+

Execute the following command from the [Command Window].

>JRRANGE 3, -38339, 0 ' Sets the pulse range of Joint #3

- (10) Using the Pulse command (Go Pulse command), move Joint #3 to the lower limit position of the pulse range at low speed. If the mechanical stop range is less than the pulse range, Joint #3 will hit the mechanical stop and an error will occur. When the error occurs, either change the pulse range to a lower setting or extend the position of the mechanical stop within the limit.



If it is difficult to check whether Joint #3 hits a mechanical stop, turn OFF the Controller and lift the arm top cover to check the condition causing the problem from the side.

Example: When lowering the mechanical stop by 20 mm and changing the lower limit Z coordinate value to “-130” in 150 mm stroke

EPSON  
RC+

Execute the following commands from the [Command Window].

>MOTOR ON ' Turns ON the motor

>SPEED 5 ' Sets low speed

>PULSE 0, 0, -38339, 0 ' Moves to the lower limit-pulse position of Joint #3.  
 (In this example, all pulses except those for Joint #3 are “0”. Substitute these “0s” with the other pulse values specifying a position where there is no interference even when lowering Joint #3.)

### 5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator (for Joints #1 and #2)

Use this method to set the upper and lower limits of the X and Y coordinates.

This setting is only enforced by software. Therefore, it does not change the physical range. The maximum physical range is based on the position of the mechanical stops.

EPSON  
RC+

Set the XYLim setting on the [XYZ Limits] panel shown by selecting [Tools]-[Robot Manager].

(You may also execute the XYLim command from the [Command Window].)

### 5.4 Standard Motion Range

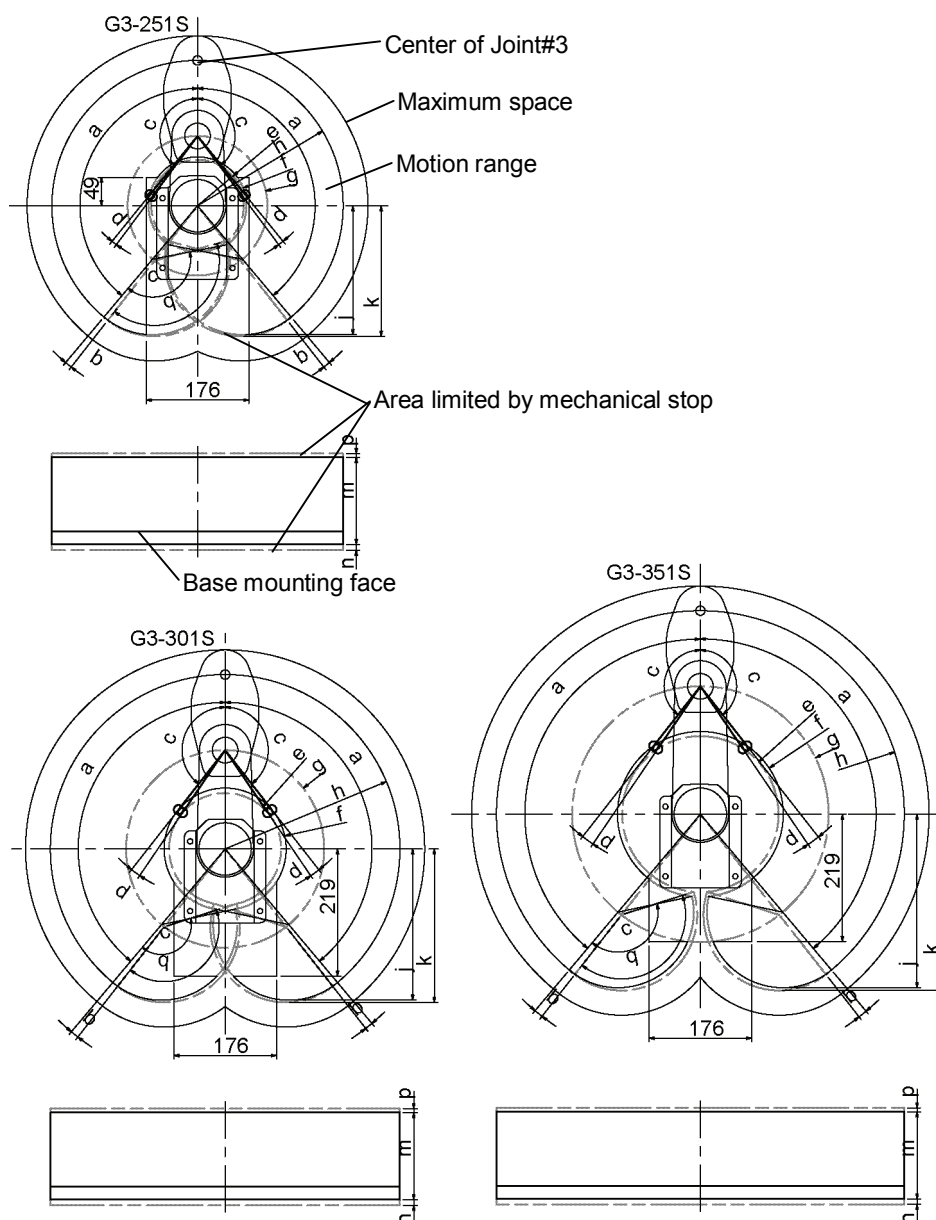
The following “motion range” diagrams show the standard (maximum) specification. When each Joint motor is under servo control, the center of Joint #3’s (shaft’s) lowest point moves in the areas shown in the figure.

“Area limited by mechanical stop” is the area where the center of Joint #3’s lowest point can be moved when each joint motor is not under servo control.

“Mechanical stop” sets the limited motion range so that the center of Joint #3 cannot move beyond the area mechanically.

“Maximum space” is the area that contains the farthest reach of the arms. If the maximum radius of the end effector is over 60 mm, add the “Area limited by mechanical stop” and “radius of the end effector”. The total value is specified as the maximum area.

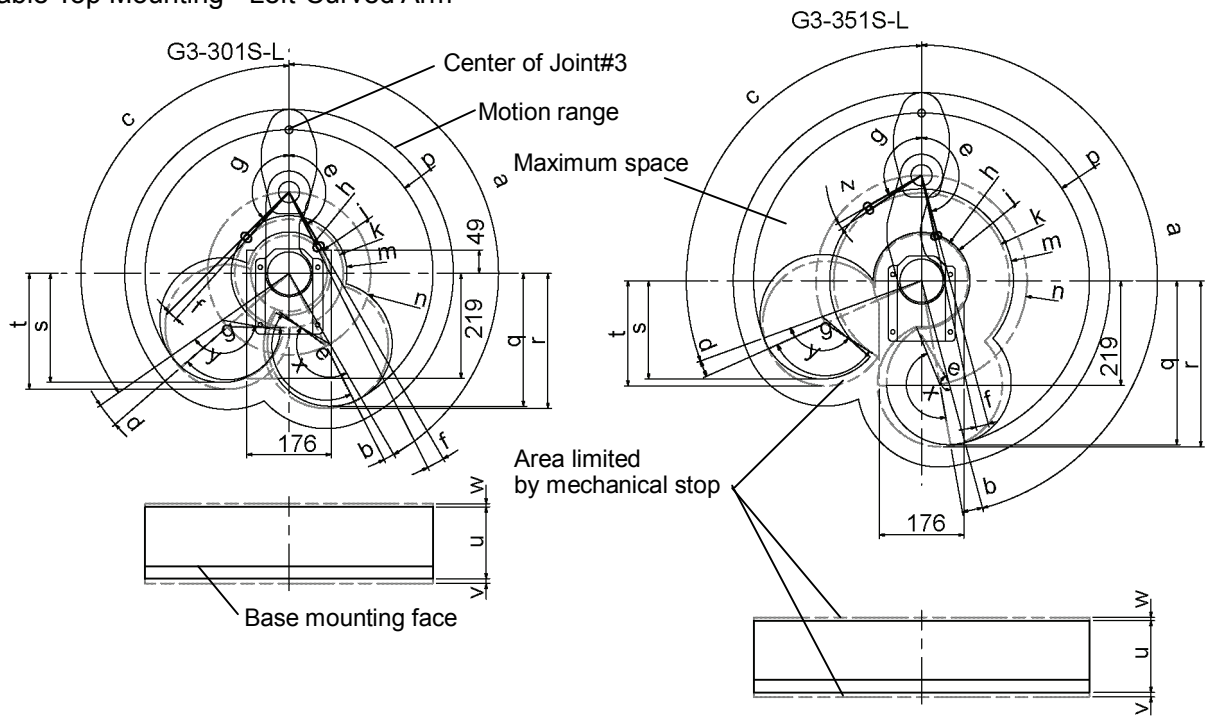
Table Top Mounting - Strait Arm



	a	b	c	d	e	f	g	h	j	k	q	m	n	p
G3-251S	140°	2°	141°	2.3°	79.3	84.0	120	250	221.9	224.5	143.3°	150	9.6	6.7
G3-251C			137°	6.3°		92.0						120	4.1	10.7
G3-301S			142°	3.8°	96.2	104.8	170	300	260.2	263.9	145.8°	150	9.6	6.7
G3-301C			142°	3.8°		107.1						120	4.1	10.7
G3-351S			142°	3.8°	134.2	142.3	220	350	298.5	303.3		150	9.6	6.7
G3-351C			142°	3.8°	2	146.6						120	4.1	10.7

(°: degree)

Table Top Mounting - Left-Curved Arm

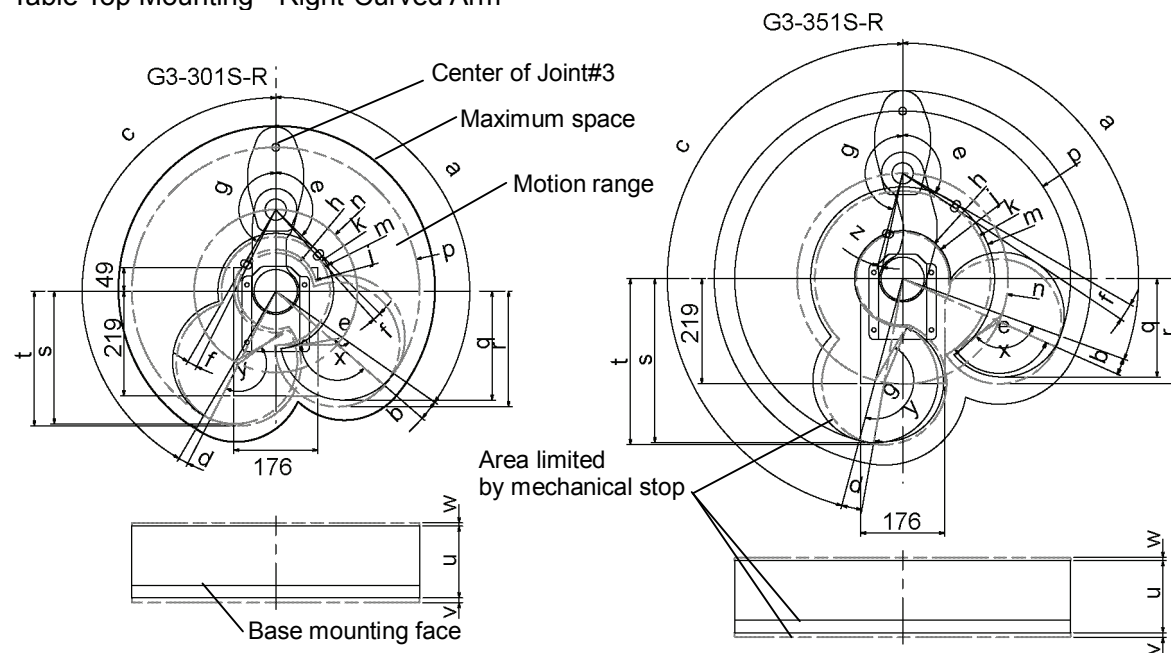


	a	b	c	d	e	f	g	h	j	k	m	n	p	q
G3-301S-L	150°	3°	125°	6°	150°	3.3°	135°	79.5	86.8	113.2	120.7	170	300	277.2
G3-301C-L					145°	8.3°								277.2
G3-351S-L	165°	5°	110°	4°	165°	2.8°	120°	96.9	100.3	183.0	191.6	220	350	342.5
G3-351C-L					160°	7.8°								

	r	s	t	u	v	w	x	y	z
G3-301S-L	281.4	227.5	241.5	150	9.6	6.7	153.3°	138.3°	—
G3-301C-L	288.7	201.8	227.5	120	4.1	10.7			3.8°
G3-351S-L	346.6	205.2	219.4	150	9.6	6.7	167.8°	123.8°	3.8°
G3-351C-L			222.9	120	4.1	10.7			

(°: degree)

Table Top Mounting - Right-Curved Arm

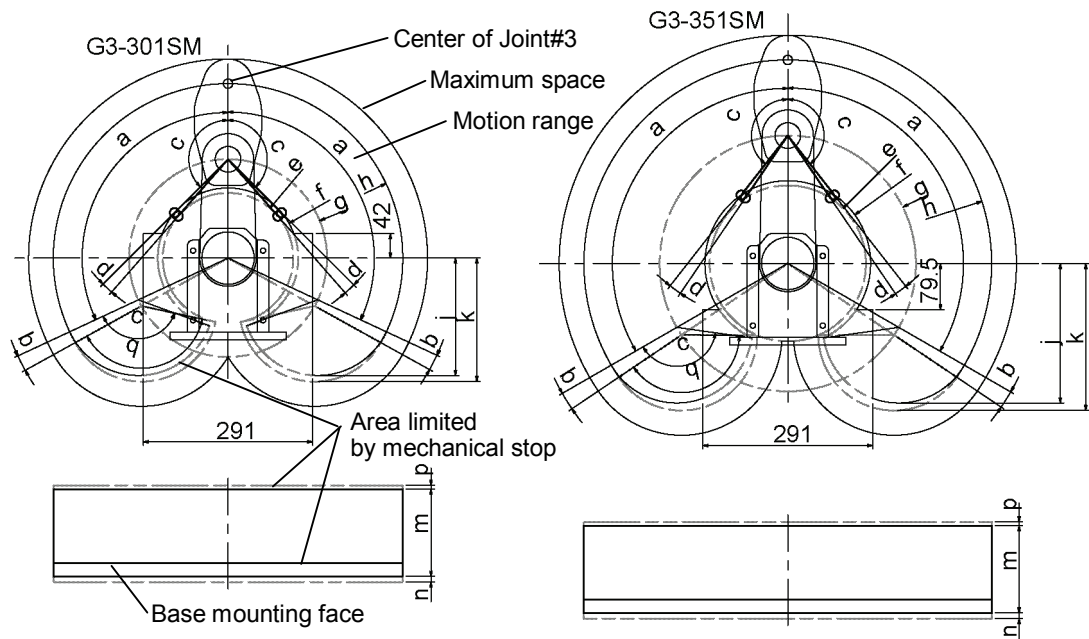


	a	b	c	d	e	f	g	h	j	k	m
G3-301S-R	125°	6°	150°	3°	135°	3.3°	150°	79.5	86.8	113.2	120.7
G3-301C-R	150°	3°	125°	6°	145°	8.3°	145°				
G3-351S-R	110°	4°	165°	5°	120°	3.8°	165°	96.9	100.3	183.0	191.6
G3-351C-R							160°				

	n	p	q	r	s	t	u	v	w	x	y	z
G3-301S-R	170	300	227.5	241.5	277.2	281.4	150	9.6	6.7	138.3°	153.3°	—
G3-301C-R			201.8	227.5		288.7	120	4.1	10.7			8.3°
G3-351S-R	220	350	205.2	219.4	342.5	346.6	150	9.6	6.7	123.8°	167.8°	2.8°
G3-351C-R			222.9	222.9		346.6	120	4.1	10.7			7.8°

(°: degree)

Multiple Mounting : Strait Arm

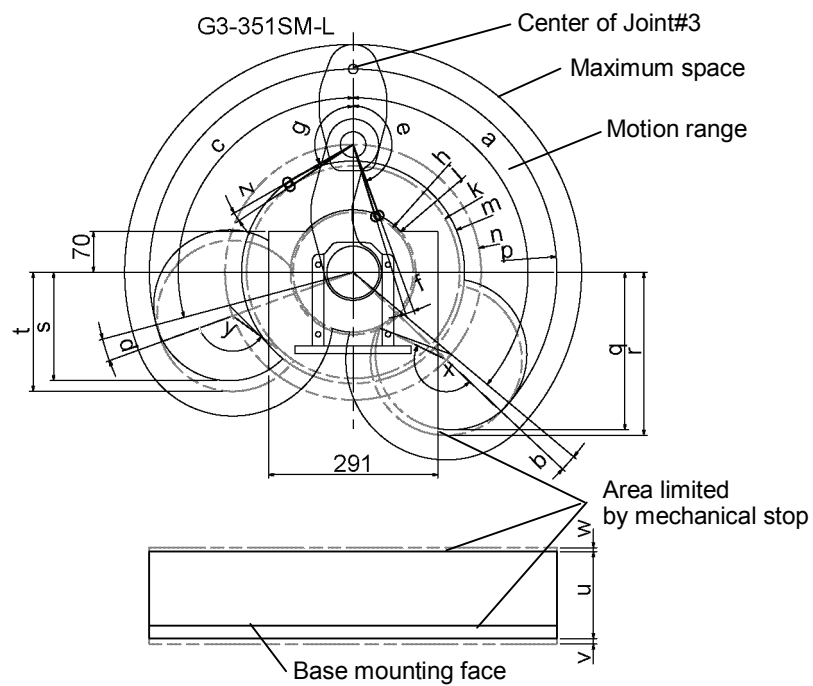


	a	b	c	d	e	f	g	h	j	k	q
G3-301SM/CM	115°	4°	135°	3.8°	112.0	120.7	170	300	201.8	212.4	138.8°
G3-351SM/CM	120°		142°		134.2	142.3	220	350	240.0	253.0	145.8°

	m	n	p
G3-301SM	150	9.6	6.7
G3-301CM	120	4.1	10.7
G3-351SM	150	9.6	6.7
G3-351CM	120	4.1	10.7

(°: degree)

Multiple Mounting : Left-Curved Arm



	a	b	c	d	e	f	g	h	j	k	m
G3-351SM-L	130°	3.3°	105°	5°	160°	2.8°	120°	103.3	125.6	183.0	191.6
G3-351CM-L		2°			150°	12.8°		125.6	140.5		

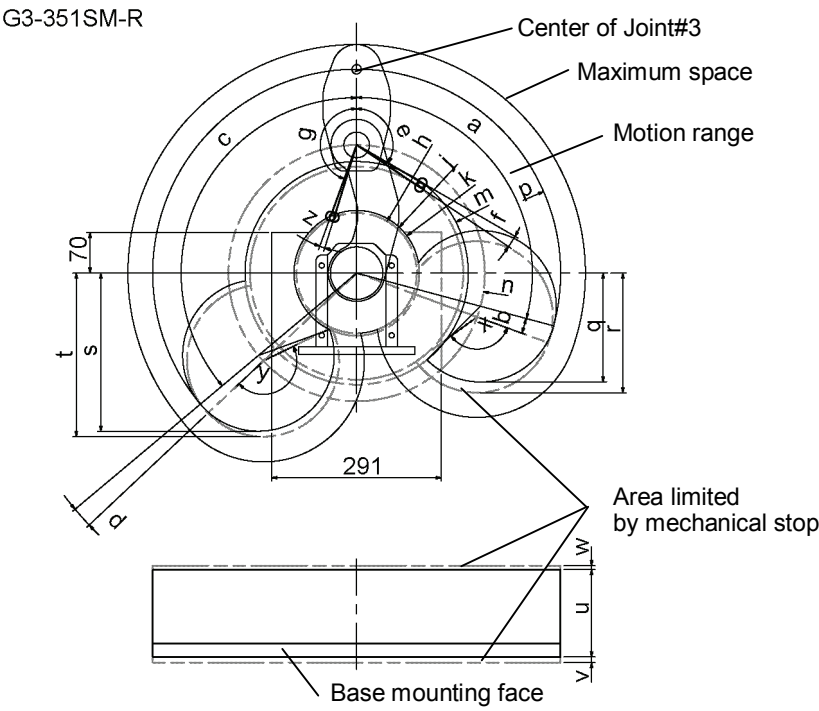
	n	p	q	r	s	t	x	y	z
G3-351SM-L	220	350	271.4	280.8	186.9	205.2	162.8°	123.8°	3.8°
G3-351CM-L				277.2					

	u	v	w
G3-351SM-L	150	9.6	6.7
G3-351CM-L	120	4.1	10.7

(°: degree)



Multiple Mounting : Right-Curved Arm



	a	b	c	d	e	f	g	h	j	k	m
G3-351SM-R	105°	5°	130°	3.3°	120°	3.8°	160°	103.3	125.6	183.0	191.6
G3-351CM-R				2°			150°	125.6	140.5		

	N	p	q	r	s	t	x	y	z
G3-351SM-R	220	350	186.9	205.2	271.4	280.8	123.8°	162.8°	2.8°
G3-351CM-R						277.2			12.8°

	u	v	w
G3-351SM-R	150	9.6	6.7
G3-351CM-R	120	4.1	10.7

(°: degree)



# Maintenance

This volume contains maintenance procedures with safety precautions for G3 series Manipulators.



# 1. Safety Maintenance



Please read this chapter, this manual, and other relevant manuals carefully to understand safe maintenance procedures before performing any routine maintenance.

Only authorized personnel who have taken safety training should be allowed to maintain the robot system.

Safety training is the program for industrial robot operators that follows the laws and regulations of each nation.

The personnel who have taken safety training acquire knowledge of industrial robots (operations, teaching, etc.), knowledge of inspections, and knowledge of related rules/regulations.

The personnel who have completed the robot system-training and maintenance-training classes held by the manufacturer, dealer, or locally-incorporated company are allowed to maintain the robot system.

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ Do not remove any parts that are not covered in this manual. Follow the maintenance procedure strictly as described in this manual. Improper removal of parts or improper maintenance may not only cause improper function of the robot system but also serious safety problems.</li> <li>■ Keep away from the Manipulator while the power is ON if you have not taken the training courses. Do not enter the operating area while the power is ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even it seems to be stopped.</li> <li>■ When you check the operation of the Manipulator after replacing parts, be sure to check it while you are outside of the safeguarded area. Checking the operation of the Manipulator while you are inside of the safeguarded area may cause serious safety problems as the Manipulator may move unexpectedly.</li> <li>■ Before operating the robot system, make sure that both the Emergency Stop switches and safeguard switch function properly. Operating the robot system when the switches do not function properly is extremely hazardous and may result in serious bodily injury and/or serious damage to the robot system as the switches cannot fulfill their intended functions in an emergency.</li> </ul>
 <b>WARNING</b>	<ul style="list-style-type: none"> <li>■ To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.</li> <li>■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.</li> </ul>



CAUTION

- Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

## 2. General Maintenance

This chapter describes maintenance inspections and procedures. Performing maintenance inspections and procedures properly is essential for preventing trouble and ensuring safety. Be sure to perform the maintenance inspections in accordance with the schedule.

### 2.1 Schedule for Maintenance Inspection

Inspection points are divided into five stages: daily, monthly, quarterly, biannual, and annual. The inspection points are added every stage.

If the Manipulator is operated for 250 hours or longer per month, the inspection points must be added every 250 hours, 750 hours, 1500 hours, and 3000 hours operation.

	Inspection Point				
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection
1 month (250 h)	Inspect every day	√			
2 months (500 h)		√			
3 months (750 h)		√	√		
4 months (1000 h)		√			
5 months (1250 h)		√			
6 months (1500 h)		√	√	√	
7 months (1750 h)		√			
8 months (2000 h)		√			
9 months (2250 h)		√	√		
10 months (2500 h)		√			
11 months (2750 h)		√			
12 months (3000 h)		√	√	√	√
13 months (3250 h)		√			
⋮	⋮	⋮	⋮	⋮	⋮

h = hour

## 2.2 Inspection Point

### 2.2.1 Inspection While the Power is OFF (Manipulator is not operating)


Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary. (For the tightening torque, refer to <i>Maintenance: 2.4 Tightening Hexagon Socket Head Cap Bolts.</i> )	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each arm locking bolts	√	√	√	√	√
	Bolts/screws around shaft					√
	Bolts/screws securing motors, reduction gear units, etc.					√
Check looseness of connectors. If the connectors are loosen, push it securely or tighten.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
	Manipulator cable unit		√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check tension of timing belts. Tighten it if necessary.	Inside of Arm #2				√	√
Grease conditions	Refer to <i>Maintenance: 2.3 Greasing.</i>					

### 2.2.2 Inspection While the Power is ON (Manipulator is operating)

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check motion range	Each joint					√
Move the cables back and forth lightly to check whether the cables are disconnected.	External cables (including cable unit of the Manipulator)				√	√
Push each arm in MOTOR ON status to check whether backlash exists.	Each arm					√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√
Measure the accuracy repeatedly by a gauge.	Whole					√


## 2.3 Greasing

The ball screw spline and reduction gear units need greasing regularly. Only use the grease specified in the following table.

 <b>CAUTION</b>	<p>■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will damage sliding parts and/or result in insufficient function of the Manipulator. Once the parts are damaged, a lot of time and money will be required for the repairs.</p>
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	Greasing part	Greasing Interval	Grease	Refer to:
Joint #3	Ball screw spline shaft	First time: after 50 km operation 2nd or more: after 100 km operation	AFB	<i>Maintenance: 10.1 Greasing the Ball Screw Spline Unit</i>
Joint #1 Joint #2	Reduction gear units	In the replacement of motor*	SK-1A	<i>Maintenance: 5.2 Replacing the Joint #1 Reduction Gear Unit 6.2 Replacing the Joint #2 Reduction Gear Unit</i>

\* Under normal conditions, the reduction gear units shall be greased only when the motor is replaced. However, in case of severe working conditions (such as high duty, high speeds, large payloads, etc.), the reduction gear units must be greased every 10,000 hours.

 <b>CAUTION</b>	<p>■ If grease gets into your eyes, mouth, or on your skin, follow the instructions below.</p> <p>If grease gets into your eyes : Flush them thoroughly with clean water, and then see a doctor immediately.</p> <p>If grease gets into your mouth : If swallowed, do not induce vomiting. See a doctor immediately. : If grease just gets into your mouth, wash out your mouth with water thoroughly.</p> <p>If grease gets on your skin : Wash the area thoroughly with soap and water.</p>
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## 2.4 Tightening Hexagon Socket Head Cap Bolts

Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a “bolt” in this manual.) These bolts are fastened with the tightening torques shown in the following table.

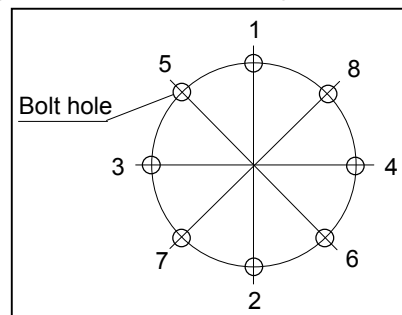
When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

Bolt	Tightening Torque
M3	245 N·cm (25 kgf·cm)
M4	490 N·cm (50 kgf·cm)
M5	980 N·cm (100 kgf·cm)
M6	1,760 N·cm (180 kgf·cm)
M8	3,720 N·cm (380 kgf·cm)
M10	7,350 N·cm (750 kgf·cm)
M12	12,740 N·cm (1,300 kgf·cm)

Refer below for the set screw.

Set Screw	Tightening Torque
M4	245 N·cm (25 kgf·cm)
M5	392 N·cm (40 kgf·cm)

We recommend that the bolts aligned on a circumference should be fastened in a crisscross pattern as shown in the figure below.



Do not fasten all bolts securely at one time. Divide the number of times that the bolts are fastened into two or three and fasten the bolts securely with a hexagonal wrench. Then, use a torque wrench so that the bolts are fastened with tightening torques shown in the table above.

## 2.5 Matching Origins

After parts have been replaced (motors, reduction gear units, a brake, timing belts, a ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.

The method of calibration is different depending on the software used. Refer to *Maintenance: 13. Calibration* and follow the steps that pertain to the software you are using.

For calibration, the pulse values for a specific position must be recorded in advance. Before replacing parts, select easy point (pose) data from the registered point data to check the accuracy. Then, follow the steps below to display the pulse values and record them.

EPSON  
RC+

Execute the following command from the [Command Window].

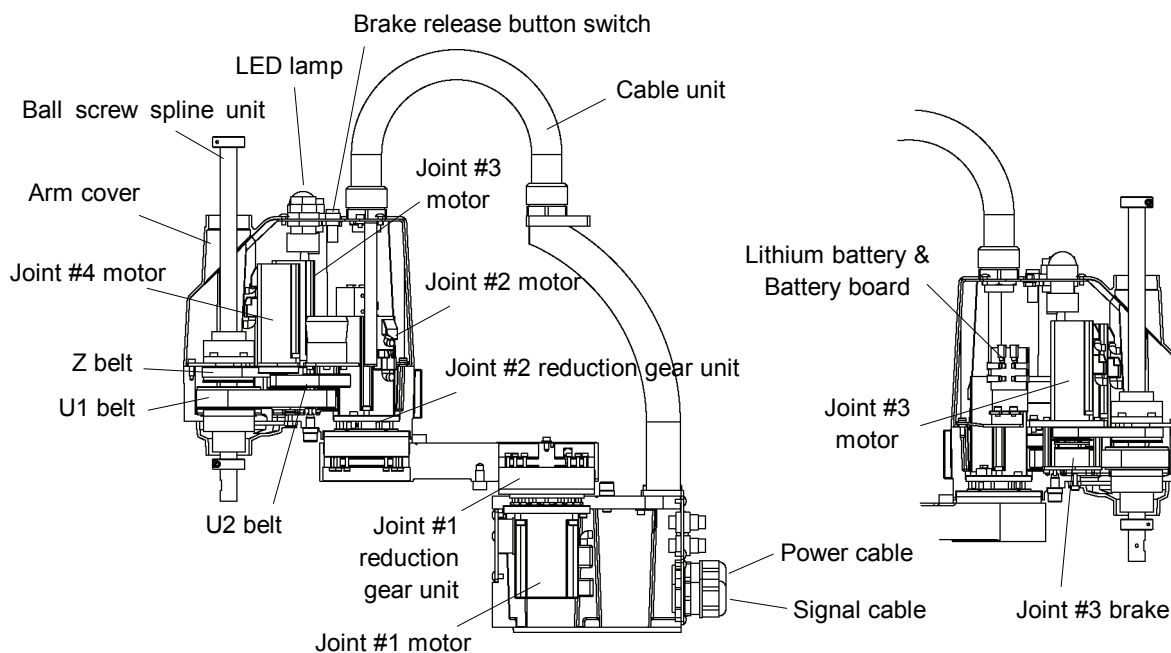
>PULSE

PULSE: [Joint #1 Pulse value] pls [Joint #2 Pulse value] pls [Joint #3 Pulse value]  
pls [Joint #4 Pulse value] pls

## 2.6 Layout of Maintenance Parts

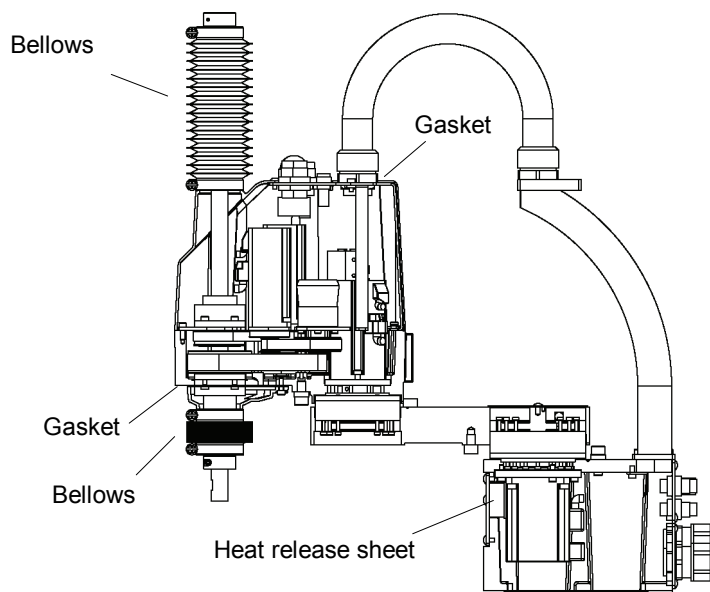
### 2.6.1 Table Top Mounting

G3-\*\*1S : Standard-model



(Figure: G3-301S)

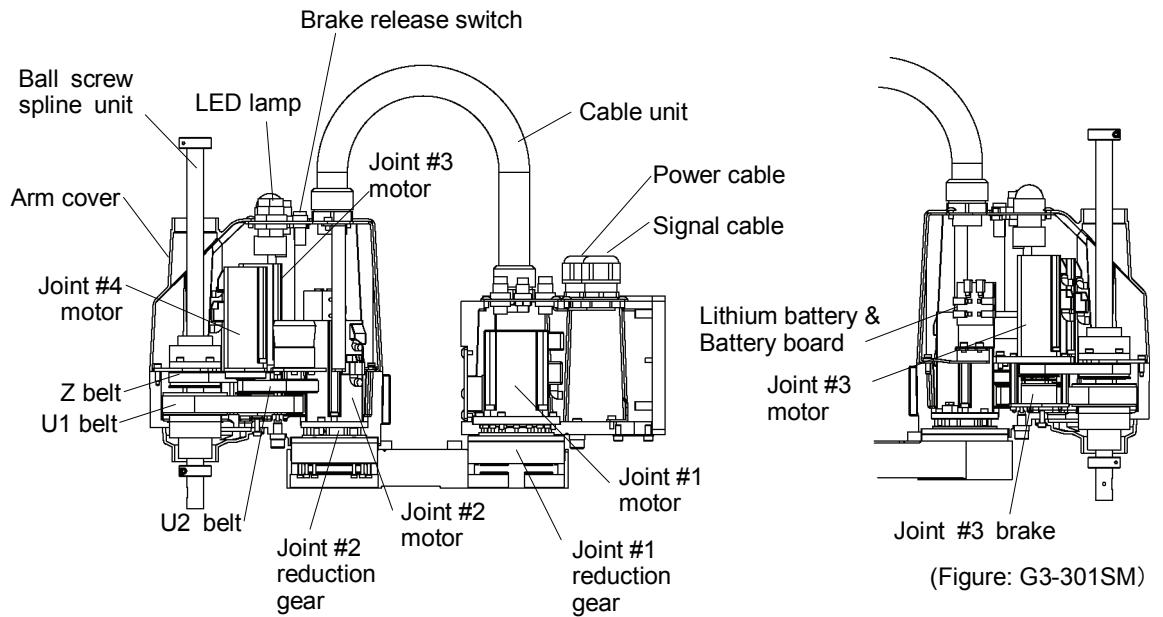
G3-\*\*1C : Cleanroom-model (with bellows)



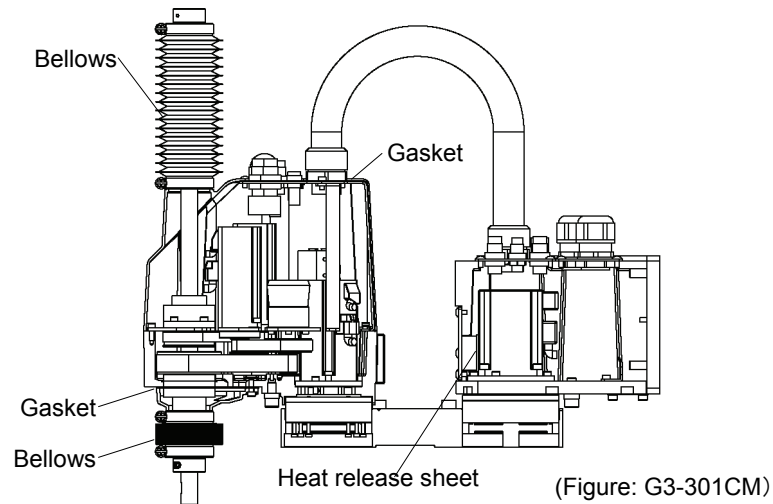
(Figure: G3-301C)

## 2.6.2 Multiple Mounting

### G3-\*\*1SM : Standard-model




### G3-\*\*1CM : Cleanroom-model (with bellows)



### 3. Covers

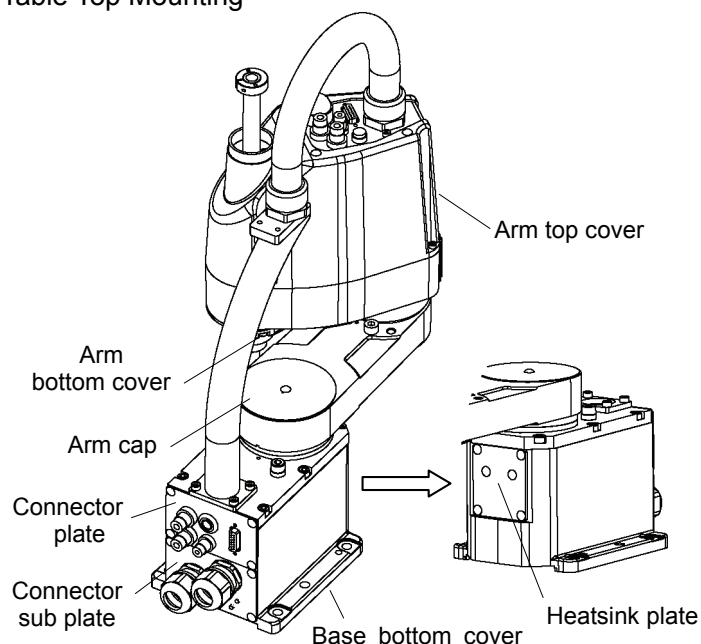
All procedures for removing and installing covers in maintenance are described in this chapter.

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>Do not insert or pull out the motor connectors while the power to the robot system is turned ON. Inserting or pulling out the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system.</li> <li>To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.</li> <li>Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.</li> <li>Be careful not to get any foreign substances in the Manipulator, connectors, and pins during maintenance. Turning ON the power to the robot system when any foreign substances exist in them is extremely hazardous and may result in electric shock and/or malfunction of the robot system.</li> </ul>
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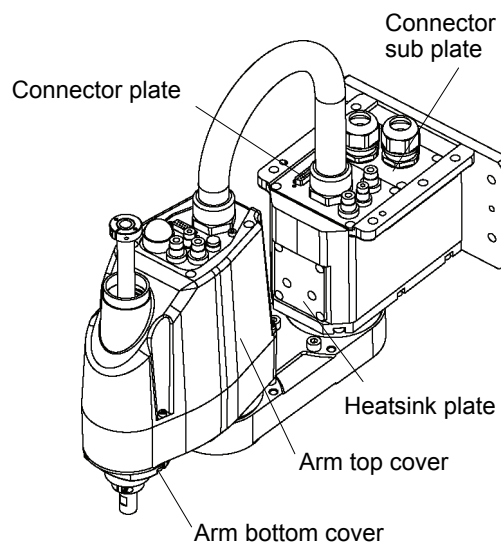
#### Maintenance Parts and Tools

	Name	Quantity	Note	
Maintenance parts	Under cover gasket	1	R13B031226	Only for Cleanroom-model
	Silicon adhesive (for the gasket on the Connector Plate)	1	R13B031227	Only for Cleanroom-model
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw	Only for Cleanroom-model
	Torque wrench	1		
	Cross-point screwdriver	1	For bellows removal	Only for Cleanroom-model
	Wiping cloth	1	For wiping adhesive	

Table Top Mounting



Multiple Mounting



### 3.1 Arm Top Cover



- Do not remove the arm top cover forcibly. Removing the cover forcibly may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.  
When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.

#### Arm Top Cover Removal

- (1) Turn ON the Controller.
- (2) Press and hold the brake release button switch to let the shaft down. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.



The brake release button switch affects only Joint #3. When the brake release button switch is pressed, the brake for Joint #3 is released simultaneously.

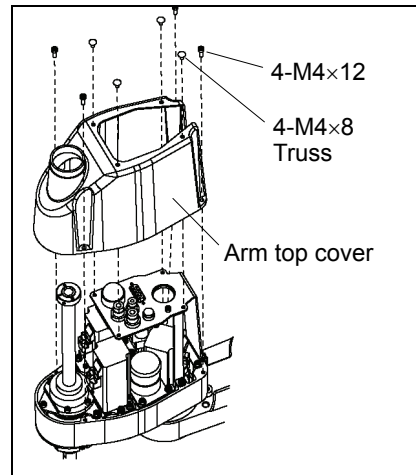
Be careful of the shaft while the brake release button switch is being pushed because it may be lowered by the weight of an end effector.

- (3) Turn OFF the Controller.
- (4) Unscrew the arm top cover mounting bolts, and then lift the cover.



When bellows are installed to the manipulator, remove the upper bellows and then remove the arm top cover. For bellows removal, refer to *Maintenance 9. Bellows*.

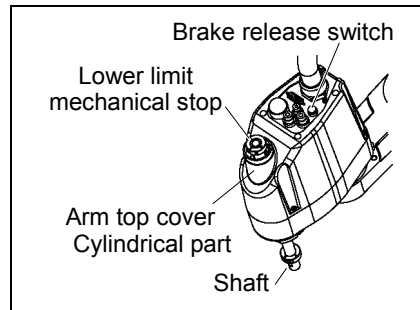
Be careful for user wires and tubes when removing the cover.



#### Arm Top Cover Installation

- (1) Set the arm top cover to the arm and secure with the arm top cover mounting bolts.

After mounting the arm top cover, make sure that the lower limit mechanical stop does not touch the cylindrical part of the arm top cover.



- (2) When bellows are installed to the manipulator, install the arm top cover and then install the upper bellows.

For bellows installation, refer to *Maintenance 9. Bellows*.

## 3.2 Arm Bottom Cover

Unscrew the arm bottom cover mounting bolts, and then pull the cover downward and remove it.



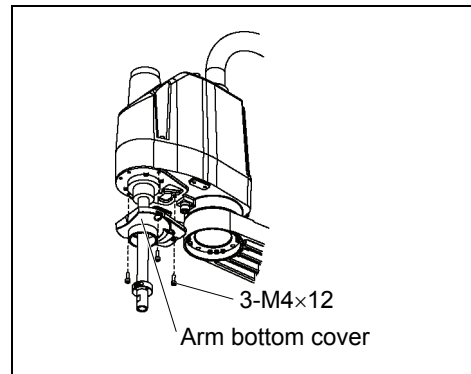
The arm bottom cover may not be removed from the shaft because the end effector is installed.

If it is necessary to remove the cover completely (for replacement of the ball screw spline unit etc.), remove the end effector.

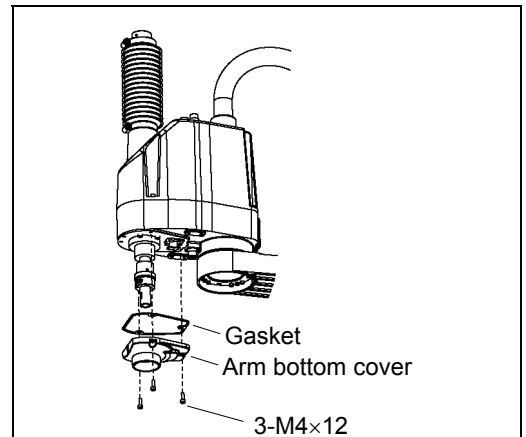
If it is not necessary to remove the cover completely, move the shaft to the lower limit, and lower the arm bottom cover. Then, perform maintenance or inspection.

When bellows are installed to the manipulator, remove or pull down the lower bellows and then remove the arm bottom cover. For bellows removal, refer to *Maintenance 9. Bellows*.

G3-\*\*1S\* (Standard-model)



G3-\*\*1C\* (Cleanroom-model)



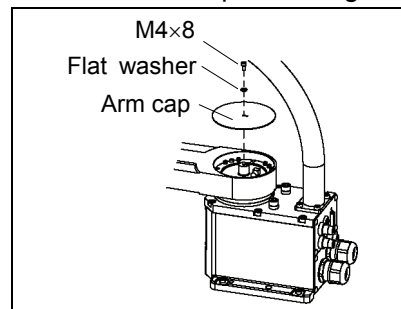
A gasket is installed to G3-\*\*1C\* (Cleanroom-model).

## 3.3 Arm Cap

Unscrew the arm cap mounting bolts and remove the cover.

Arm cap is not installed to the Multiple Mounting Manipulators.

G3-\*\*1 Table Top Mounting



### 3.4 Connector Plate

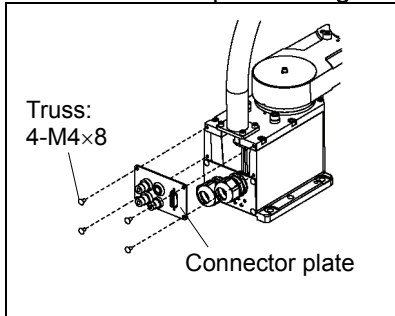


CAUTION

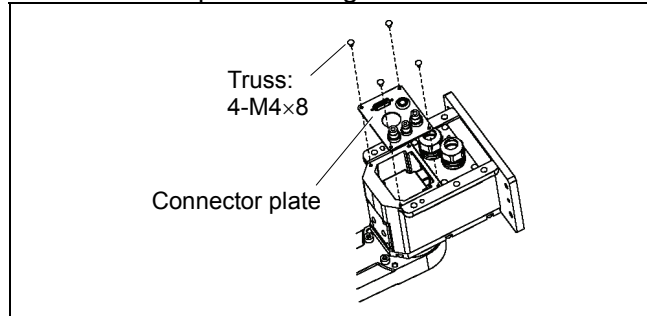
- Do not remove the connector plate forcibly. Removing the connector plate forcibly may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the connector plate, be careful not to allow the cables to interfere with the plate mounting and do not bend these cables forcibly to push them into the cover.  
Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.  
When routing the cables, observe the cable locations after removing the connector plate. Be sure to place the cables back to their original locations.

Unscrew the connector plate mounting bolts and remove the plate.

G3-\*\*1\* Table Top Mounting



G3-\*\*1\*W Multiple Mounting





### 3.5 Connector Sub Plate

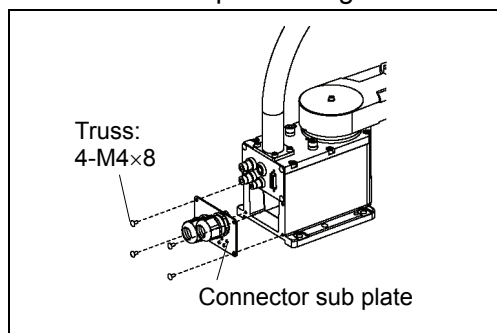


CAUTION

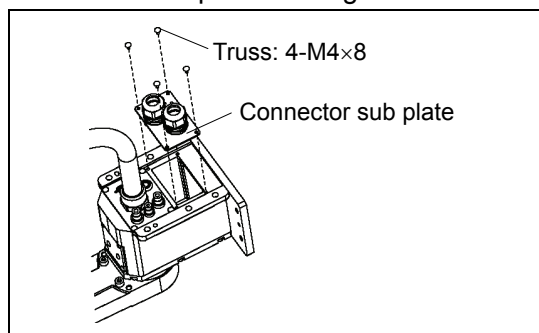
- Do not remove the connector sub plate forcibly. Removing the connector sub plate forcibly may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the connector sub plate, be careful not to allow the cables to interfere with the plate mounting and do not bend these cables forcibly to push them into the cover.  
Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.  
When routing the cables, observe the cable locations after removing the connector sub plate. Be sure to place the cables back to their original locations.

Unscrew the connector sub plate mounting bolts and remove the plate.

G3-\*\*1\* Table Top Mounting



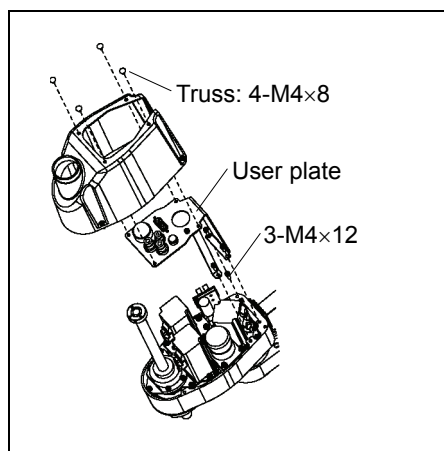
G3-\*\*1\*W Multiple Mounting



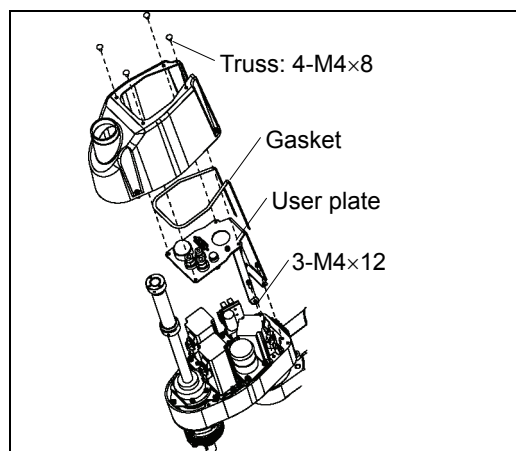
### 3.6 User Plate

Unscrew the user plate mounting bolts and remove the plate.

G3-\*\*1S\* Standard-model



G3-\*\*1C\* Cleanroom-model

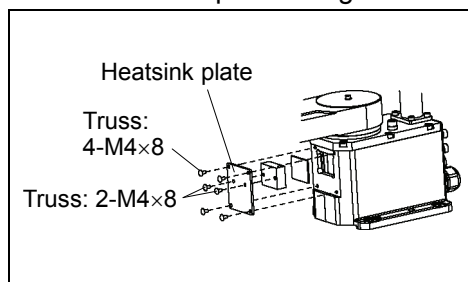


A gasket is installed to G3-\*\*1C\* (Cleanroom-model).

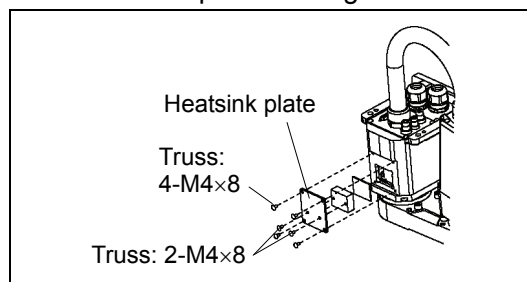
## 3.7 Heatsink Plate

Unscrew the heatsink plate mounting bolts to remove the plate.

G3-\*\*1\* Table Top Mounting



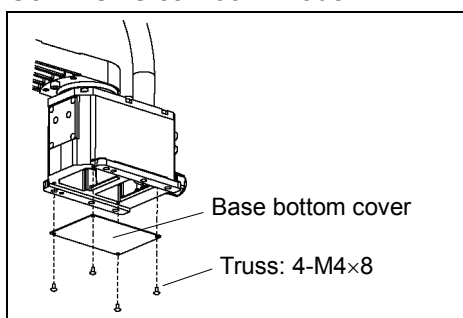
G3-\*\*1\*W Multiple Mounting



## 3.8 Base Bottom Cover

Unscrew the base bottom cover mounting bolts and remove the cover.

G3-\*\*1C\* Cleanroom-model



A base bottom cover is not installed to G3-\*\*1S\* (Standard-model).

## 4. Maintenance Parts List

### 4.1 Common Parts

Part Name			Code	Note
Cable Unit	S/C	250 mm	R13B020023	
		300 mm	R13B020024	
		350 mm	R13B020025	
	SM/CM	300 mm	R13B020026	
		350 mm	R13B020027	
M/C Cable	Cable Length 3 m		R12B020431	
	Cable Length 5 m		R12B020432	
	Cable Length 10 m		R12B020433	
AC Servo Motor	Joint #1		R13B000614	200 W
	Joint #2 / #3 / #4		R13B000615	150 W
Reduction Gear Unit	Joint #1		R13B010016	SHG20-80
	Joint #2		R13B010017	SHG17-50
Solenoid Brake	Z axis		R13B030501	
Timing Belt	Joint #3		R13B030213	Z :
	Joint #4		R13B030214	U1 :
			R13B030215	U2 :
O-ring	Joint #1		R13A030700200	For SHG-20
	Joint #2		R13A030700100	For SHG-17
	Joint #1		R13A030700700	O-ring20
	Joint #2		R13A030700600	O-ring17
Brake Release Switch			R13Z702640100	
Oil seal unit			R13B031233	
Battery Board			R13B041202	With lithium battery Installed in Arm #2
Battery Unit			R13ZA00600300	Lithium battery for replacement
LED Lamp			R13A030000200	
Grease	Ball Screw Spline		R13ZA00330200	AFB grease (400 g)
	Reduction Gear Unit		R13ZA00330100	SK-1A (500 g)
	Cable		R13B030304	Tube of GPL-224 (227 g)

## 4.2 Parts by Environment Model

### 4.2.1 S: Standard-model

Part Name		Code	Note
Ball Screw Spline	150 mm	R13B010220	
Arm Cover		R13B030421	White
Arm Bottom Cover		R13B030423	

### 4.2.2 C: Cleanroom-model

Part Name		Code	Note
Ball Screw Spline	120 mm	R13B010221	
Arm Cover		R13B030422	Plating
Arm Bottom Cover		R13B030424	
Bellows		R13B030704	
Gasket Unit		R13B031234	